2022 Pennsylvania Vegetable Marketing and Research Program
Pennsylvania Vegetable Growers Association Report
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Title: **Impact of Management Practices on Soil Health Indicators in Conventional and Organic Vegetable Cropping Systems (Year 3)**

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Introduction:

Soil health may vary with field management practices and cropping systems. Tillage type and frequency of tilling soil play a major role in nutrient cycling and building or depletion of soil organic matter. Soil health indicators vary in their sensitivity to practices and cropping systems.

Since the project was partially funded by the PA Vegetable Marketing and Research Program, in this report we are documenting information on selected soil health indicators in soil samples taken in 0-10cm and 10-20 cm soil depth in the long-term Vegetable Systems Trial (VST) at Rodale Institute. Soil samples were collected from 48 plots in fall 2022. The objectives of the project were to 1) assess selected soil chemical and biological properties in 48 plots at top two soil depths collected in fall 2022, and 2) disseminate the results to growers using various venues.

Materials and Methods:

Deep soil samples were collected from five soil depths in the Vegetable Systems Trial (VST) at Rodale Institute in fall 2022. The sampling represents the end of the 3-year crop rotation. The five soil depths included 0-10cm, 10-20cm, 20-30 cm, 30-60cm and 60-100cm in black plastic mulch (BP) and reduced till (RT) plots in each of the organic and conventional systems. Selected indicators in the top 20 cm were supported by this grant and the other indicators and depths were supported by other funding sources. Four tubes of soil cores were collected per plot. Soils were transported to the laboratory at Rodale Institute for immediate processing. Soils from every three cores per depth were composited for determining chemical and biological properties and the fourth core was used to determine bulk density. For chemical properties, soils were laid out on trays and air-dried, sifted through 2.0mm sieve, subsampled and sent to Cornell University and Penn State University Agricultural Analytical Services Laboratory (AASL) for chemical properties and Ward Lab for biological properties. For biological properties (bacterial and fungal biomass), soil samples were immediately processed and placed in Ziploc bags and placed in a freezer at -20 C and shipped overnight to Wards Laboratory in January 2023 for analysis. Bulk density was determined by dividing the mass by volume at each depth.

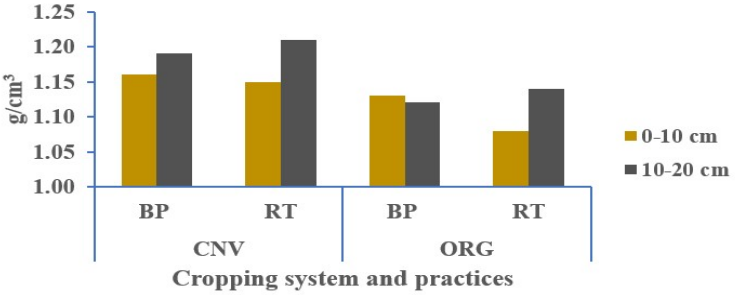
Results:

Objectives 1: Assess the physical and chemical properties in soil samples taken in 48 plots at the 0–4-inch (0- 10 cm) depth, and 4–8-inch (10-20cm) depth in VST.

Physical property (Soil Bulk Density):

Soil bulk density was greater in the conventional than in the organic system at both depths. Soil bulk density increased with depth and was more pronounced in 10-20 cm in plots with reduced tillage (RT) of either cropping system (Figure 1). The least soil bulk density was in the 0-10 cm soil depth of the organic RT.

Figure 1. Variation in soil bulk density with cropping systems, managment practices, and depth in VST, Rodale Institute, 2022



Chemical and biological properties:

Soil organic carbon (SOC) and soil organic matter (SOM):

Across the VST plots, percent soil organic carbon was greatest in the organic reduced tillage (ORG RT) plots and lowest in the conventional black plastic plots (Figure 2a). At the 10-20cm the SOC levels were not different but only in the ORG RT when compared to levels in 0-10 cm. The soil organic matter (SOM) levels were greatest in the organic reduced tillage (Figure 2b) and followed the same trend of SOC.

Figure 2a. Variation of soil organic carbon (SOC) with cropping systems, management practices and depth in VST, Rodale Institute, 2022

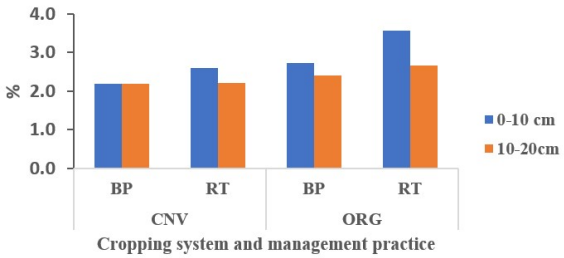
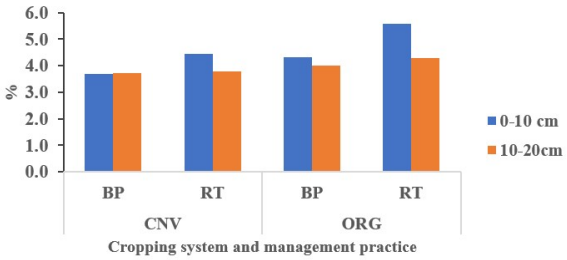


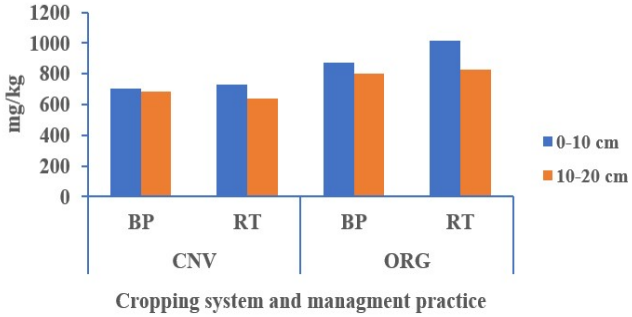
Figure 2b. Variation in soil orgamic matter (SOM) with cropping systems, managment practices, and depth, VST, Rodale Institute, 2022



Labile (Active) carbon (POX-C):

The overall mean soil labile carbon (POX-C) was greater in the organic system than in the conventional (Figure 2c). The POX-C level was greatest in the organic RT at 0-10 cm and lowest in the conventional (CNV) BP plots (Figure 2c). The soil POX-C scored 95% in the organic whereas 82% in the conventional. The 2022 soil POX-C levels were similar to those of 2021. However, the POX-C levels in the conventional decreased by approximately 100g/kg in 2022 compared to those in 2021. These results showed that with time the labile organic carbon continued to build up in the organic system and available to soil microorganisms during the growing season, enhancing nutrient cycling, but decreased in the conventional.

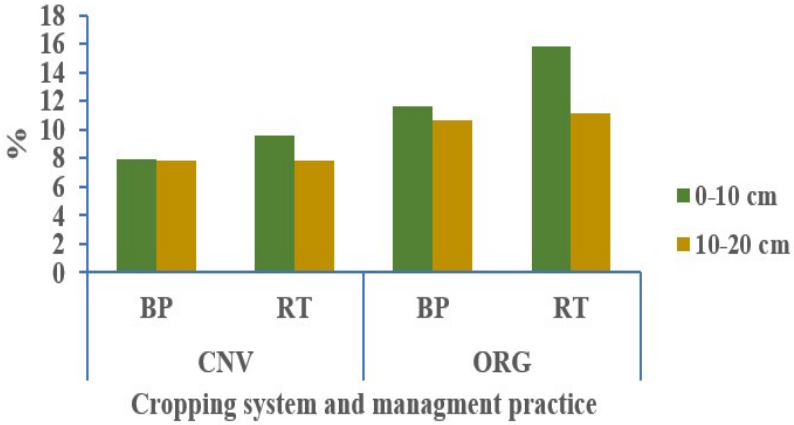
Figure 2c. Variation in mean soil labile (active) organic carbon with cropping systems, managment practices, and depth, VST ,Rodale Institute, 2022



Soil protein:

Soil protein was greatest in the organic RT at 0-10 cm and significantly different from 10-20cm (Figure 3). The overall mean soil protein was greater in the organic system than in the conventional and similarly to results in 2021. It is important to note that while soil protein in organic system has increased and especially in the RT at 0-10cm it declined in the conventional. This information validates that with time changes in the soil protein will show and become significant with depth. Vegetable growers could reap the benefit of managing their soil with minimal tillage and more nitrogen recycling will be pronounced especially when the land is cropped organically as shown in Figure 3.

Figure 3. Variation in soil protein with cropping systems and managment practices, and depth in VST, Rodale Institute, 2022

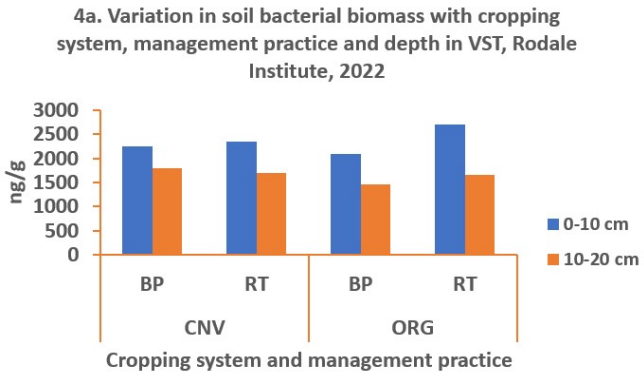


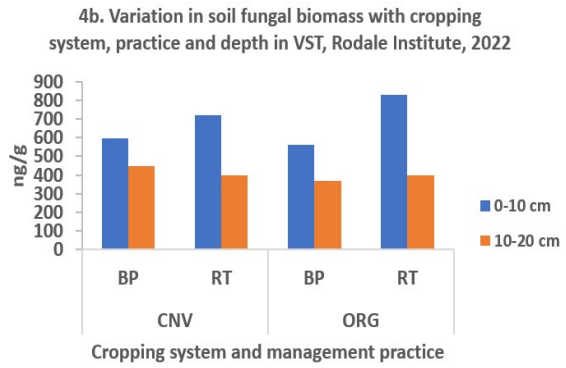
Soil bacterial and fungal biomass:

Unlike previous years, we started to see differences in soil biology with depth. Soil bacterial biomass was greater in 0-10 cm than in the 10-20cm (Figure 4a). Overall mean bacterial biomass was greatest in the organic RT followed by the conventional RT and BP and not different from ORG BP (Figure 4a). The bacterial biomass followed the same trend we found in the POX-C and protein (Figure 2 and 3, respectively).

Soil fungal biomass followed a similar trend to the bacterial biomass and was greatest in the organic RT than any other treatment at 0-10cm (Figure 4b). The RT plots, however, had greater fungal biomass than the BP plots irrespective of the cropping system at 0-10cm. The increase in the RT over the BP was about 50% in the organic and 25% in the conventional. There was no significant difference between treatments at 10-20cm.

The ratio of bacterial to fungal biomass was 3:1. This year's microbial biomass data were similar to those of 2021 in pattern, however, we much less than in 2021.





Objective 2: Disseminate the results to growers using various venues.

The time was limited between sampling and receiving results in order to disseminate the results before sending this report. However, the plan is to share the results with vegetable growers during the upcoming Rodale Institute's field day in July 2023 as well as in a webinar. This data will be a subset of the data set accumulated over the past three years and will be documented into peer-reviewed articles and educational publications.

Conclusion:

The results here showed that **the ORG RT plots had the lowest bulk density but were greatest in the SOC, SOM, protein, and soil microbial biomass levels.** This year we began to see more significant differences in the assessed soil health indicators with soil depth. Thus, these results show that continuous management of soils with minimal tillage led to better soil health scores. Vegetable growers can use this information as guidance to adopt management practices and cropping systems that improve soil health physically, chemically, and biologically.