Managing Soil Under Vegetable Production to Improve Soil Quality

Charles W. Raczkowski[1]*, M.L. McGraw[1], K.R. Baldwin[1], G.B. Reddy[1], Warren Busscher[2], and Philip Bauer[2]

[1]Department of Natural Resources and Environmental Design, North Carolina A&T State University. 1601 East Market St. Greensboro, NC 27411; [2] USDA/ARS Coastal Plains Soil, Water and Plant Research Center, 2611 W Lucas St., Florence, SC 29501-1241

Introduction

Many southeast Piedmont fields have undergone extreme losses in soil organic matter (SOM) and severe erosion and degradation as a result of intensive conventional tillage for crop production (Giddens, 1957; Trimble, 1974). Soil management aimed at increasing SOM will improve soil properties, augment soil quality and increase productivity. SOM can be increaded by conservation tillage, cover cropping and the addition of compost (Wyland et al., 1996; Gagnon et al., 1998; Hoyt, 1999; Johnson and Hoyt, 1999). Many conventional vegetable growers are hesitant to adopt these practices for a number of reasons. Some believe that it is not possible to grow vegetables without tillage while others rely on intensive cultivation methods for weed control. Others have applied manures or compost and abandon these practices because they do not see immediate benefits. Some growers become frustrated at the difficulty in increasing SOM with cover crops because of its rapid decay under southeastern climatic conditions.

Objective

To evaluate the effects of tillage, cover cropping and applied compost on soil properties and soil quality.

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Materials and Methods

The study began in the fall of 2003 at the North Carolina A&T State University farm, Greensboro, NC. The experiment was designed as a split-split plot with tillage levels (disk tillage and no tillage) assigned to main plots, cover crop levels (growing a winter cover crop and no winter cover crop grown) assigned to subplots and compost levels (compost applied and no compost applied) assigned to sub-sub plots. Chicken broiler litter compost was applied each fall at a rate of 11Mg/ha. The fall drilled cover crop, a bi-culture of crimson clover and Abruzzi rye, was spring killed using a roller/crimper apparatus. In early June either pumpkins, butternut squash or sweet corn was planted. Soil properties were measured from the upper 7.5 cm after crop harvest in the fall of 2005 and 2008. The Soil Management Assessment Framework (Andrews et al, 2004) was used to generate soil quality scores for each soil property and the overall soil quality index (SQI) value for each of the eight study treatments.

Properties Measured:
WSA = Water Stable Aggregates; BD = Bulk Density; PAW = Plant Available Water; Soil pH; EC = Electrical Conductivity; Soil P = Soil Phosphorus; TOC =Total Organic Carbon; MBC = Microbial Biomass Carbon

Photo 1
A crimson clover + rye bi-culture was planted each fall.

Photo 2
In disk tillage, the cover crop was incorporated into the soil.

Photo 3
In no tillage, the cover crop was killed and rolled to remain over the soil surface.

Photo 4, 5,6 & 7 The four subplot treatment combinations. These subplots were split into compost applied and no compost applied sub-subplots

Photo 4
Disk Tillage + No Cover Crop

Photo 5
Disk Tillage + Cover Crop

Photo 6
No Tillage + No Cover Crop

Photo 7
No Tillage + No Cover Crop

Results

• More soil property differences were found between tillage levels than between cover crop or compost levels (table 1).

•Tillage and cover cropping affected both physical and chemical properties while compost only affected chemical properties.

•The tillage x cover crop interaction was significant for few properties and most other interactions were non-significant.

•Management practices under study improved soil conditions (data tabulations on top of poster table)
DT had higher pH and lower BD and Soil P than NT.
WSA was higher in NT than in DT.
Cover cropping increased WSA, PAW, and pH.
Cover cropping also lowered BD in DT and increased TOC, TN and MBC.

•Applying compost increased pH, TOC, TN and MBC in NT.

•The practice of cover cropping and applying compost improved soil quality overall in NT and DT (Figure 1). The soil quality improvement was evident in 2005, two years after the study began.

Table 1. Results from the analysis of variance of soil parameters measured in 2005 and 2008.

Soil Property	Source of Variation†							
	Tillage (TI)	Cover (CR)	T I x CR	Compost (CO)	TI x CO	CR x CO	TI x CR x CO	Coefficient Variation %
	---------- 2005 ----------							
WSA	**	**	NS	NS	NS	NS	NS	15.6
BD	**	*	*	NS	NS	NS	NS	3.7
PAW	**	**	*	NS	NS	NS	NS	11.4
pH	*	NS	NS	*	NS	NS	NS	4.9
EC	NS	NS	NS	*	NS	NS	NS	26.4
Soil P	NS	NS	NS	NS	NS	NS	NS	22.9
TOC	*	*	**	**	NS	NS	NS	15.9
MBC	NS	NS	NS	NS	NS	NS	NS	57.3
	---------- 2008 ----------							
WSA	NS	*	NS	NS	NS	NS	NS	20.4
BD	*	NS	NS	NS	*	NS	NS	4.1
PAW	NS	**	NS	NS	NS	NS	NS	12.1
pH	*	NS	NS	**	NS	**	NS	3.5
EC	**	NS	NS	NS	NS	NS	NS	26.6
Soil P	*	NS	NS	NS	NS	NS	NS	43.3
TOC	NS	NS	NS	*	NS	NS	NS	33.8
MBC	NS	*	*	NS	*	NS	NS	31.4

† **,* significant at the 1% and 5% levels of probability, respectively. NS is non-significant.

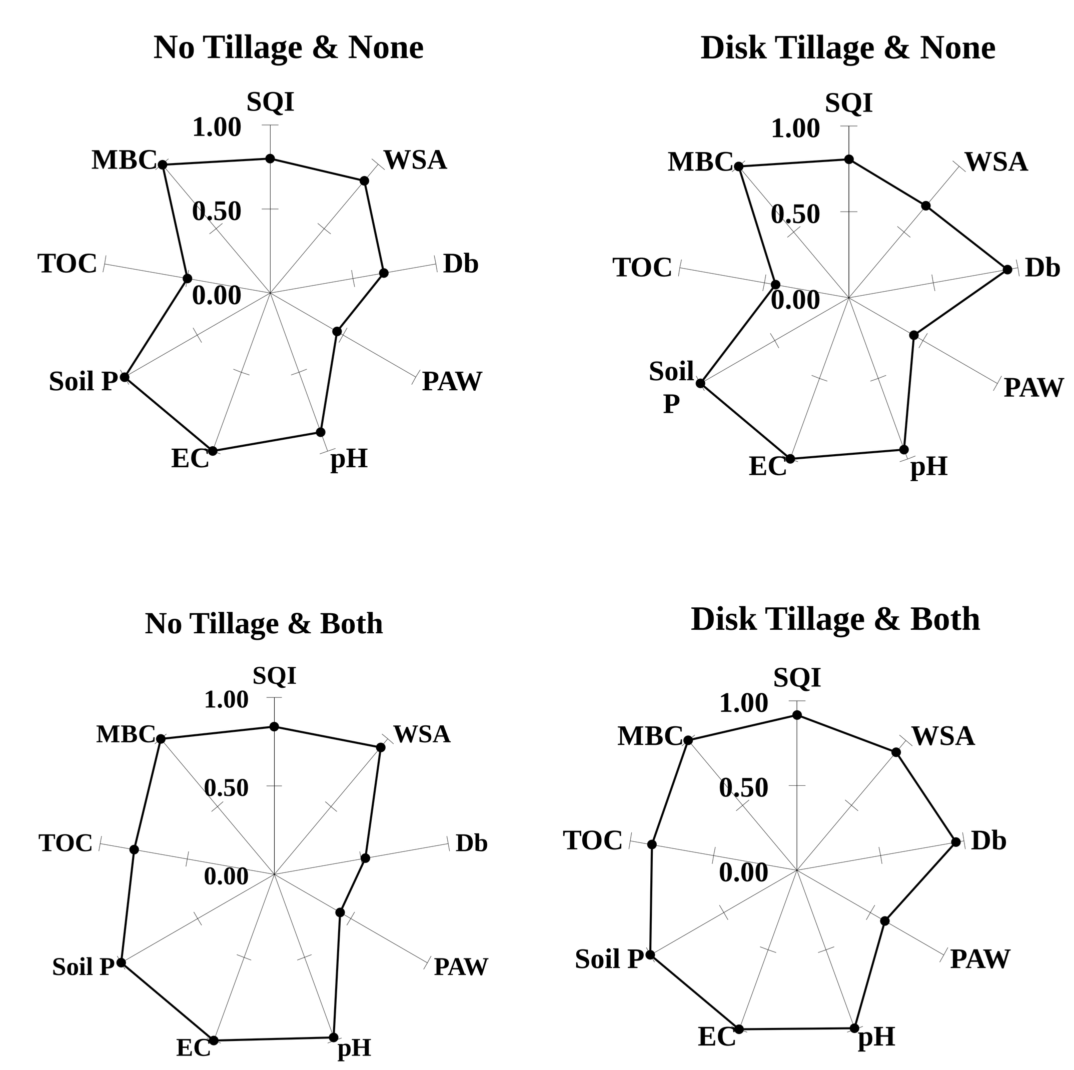

Figure 1. SMAF property scores and soil quality index (SQI) for disk and no tillage with and without cover crop and compost. Scores were generated using the 2008 soil property data.

Contact Information

Charles W. Raczkowski
Department of Natural Resources
N.C. A&T State University
Greensboro, NC 27411

Phone: 336 334 7779
Email: raczkowc@ncat.edu