STRAWBERRY SOIL STEWARDSHIP

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Soil stewardship involves the maintenance of nutrient availability, soil physical properties and biological health, in addition to preventing run-off and erosion. In perennial strawberries, erosion is rarely a concern as fields are mulched continuously and prepared for planting only once every few years. However, much attention has been paid to the maintenance of nutrient availability. Soil tests and foliar analyses are routinely used to determine chemical amendments to be added. Soil scientists have also recognized the importance of soil physical properties, most notably the negative effect of compaction on plant health. More recently, scientists have begun to study how active biological processes in the soil (i.e. microbial activity) affect plant health. However, most of this work has focused on field and vegetable crops – very little information is available for fruit crops. We have been investigating how soil compaction and soil biology affect perennial strawberry root health.

Soil physical properties: Compaction

The effect of soil compaction on strawberry root health is unknown. In the absence of standing water, is compaction alone damaging to roots? How much compaction can strawberries tolerate? A field study, pot study and a farm survey were used to better understand the relationship between soil compaction and perennial strawberry root health. In 2004, a virgin field received four preplant compaction treatments (heavy compaction, light compaction, no compaction, and subsoiling), with compaction imposed by a commercial-grade Stone Rhino road compacter. After planting, treatments were further subdivided and received three additional compaction treatments over the three-year life of the planting (management without any driven equipment, use of light equipment, and use of heavy tractor-powered equipment). Soil penetrometer readings taken over the three years reflected the various levels of imposed compaction. Stolon production and yield were recorded each year and effects of compaction on these variables were determined. Interestingly, soil compaction prior to planting had only a modest impact on yield. Relatively severe compaction between rows had a minimal effect on yield and fruit size.

Soils from three fields with a history of black root rot (eastern, central and western NY) were brought to Ithaca and subdivided into two lots. One lot was fumigated. Each of the soils was placed into 3 gallon pots and 5 levels of compaction were imposed using vermiculite to lessen compaction and mallets to increase compaction to a predetermined bulk density. One 'Jewel' was planted into each pot and grown for one year. Per plant yields were determined and root health was assessed after washing soil from the roots. Essentially, plants in fumigated soils had healthier roots, but compaction had only a slight effect on root health.

Soil penetrometer readings were taken from different-aged plantings (1 through 7 years old) at a pick-your-own strawberry farm that did not use tractor-powered equipment, to determine the cumulative effect of foot traffic on compaction. At this farm, soil compaction was similar regardless of planting age.

Strawberries seem to be tolerant of moderate soil compaction in the absence of standing water. Also, the large amount of straw that is incorporated into strawberry rows each year, and the infrequent cultivation afforded by straw mulch, has generally prevented strawberry fields from developing severe compaction problems.

Soil biological processes: Replant problems

In July 2001, a study was established in a field with a 30-year history of perennial strawberry production to examine effects on replant disorder of 12 different species of preplant cover crops, soil fumigation (methyl bromide plus chloropicrin) and fallow management. In May 2002, strawberries ('Jewel') were planted into pots containing soils with the incorporated cover crops, grown for one year, then fruited. Strawberry yields in 2003 were highest in pots containing indiangrass (*Sorghastrum avenaceum*) and brown mustard (*Brassica juncea*) incorporated soils, resulting in 32% and 28%, respectively, higher yield than plants in pots containing untreated, bare fallow soil. Yield was lowest in fumigated soil or soil incorporated with sunnhemp (*Crotolaria juncea*), having 19% and 10% less yield than the fallow treatment, respectively.

In August 1999, a complementary study was established in a field with a 7-year history of continuous perennial strawberry production to examine the effects of single species and multiple species rotations on replant disorder, bacterial populations, and fungal pathogens over two fruiting years. Cover crop treatments included various monocultures and sequences of perennial alfalfa (*Medicago sativa*), brown mustard, kale (*B. oleracea* 'Winterbor'), sweet corn (*Zea mays* 'Saccharata'), rye (*Secale cereale*), hairy vetch (*Vicia villosa*), marigold (*Tagetes patula* 'Nema-gone'), oats (*Avena sativa* 'Newdak'), and sudangrass (*Sorghum bicolor* x*S. sudanese*). These rotations were compared to the effects of fumigation using methyl bromide with chloropicrin (99:1), continuous strawberry, and bare fallow.

Symptoms of replant disorder developed in the continuous strawberry plots within a few months of planting. Plants in the fumigation treatment produced greater fruit yield than all other treatments in 2003, 139% more than plants from the continuous strawberry treatment. Strawberry plants grown in the kale/sweet corn/rye treatment had consistently high yield, and both the hairy vetch/marigold/rye and the oats/sudangrass/rye treatments led to marked improvement over the continuous strawberry treatment. Plants from the brown mustard treatment also were more vigorous and productive than plants from the continuous strawberry treatment during 2002, despite having relatively low foliar biomass and a relatively high level of fungal infection on strawberry plant roots. In the field, symptoms of replant disorder were best overcome by fumigation with methyl bromide or multiple species rotations, particularly that of kale followed by sweet corn and rye. Although *Rhizoctonia* levels were associated with poor root health, general fungal and bacterial root infection rates were not consistently associated with the presence of visible symptoms of replant disorder, nor with strawberry plant growth and productivity.

For the past 3 years, these results have been integrated into a study comparing cover crop rotations, compost amendments, and root dips with methyl bromide fumigation. The study was replicated at two farms each in Michigan and Maryland. Results suggest that managing the soil

with cover crops and composts can maintain soil health and suppress harmful pathogens without reliance on fumigants.

Soil stewardship

Scientists are beginning to study the various components of soil health and learn which are critical for plant growth and yield. Managing these components, in many cases, does not require large amount of input. Preserving soil quality with low external inputs is a key to a successful and sustainable agriculture.