

SOIL COMPACTION ON VEGETABLE FARMS

By Vern Grubinger, Vegetable and Berry Specialist, University of Vermont Extension

Soil compaction is causing trouble for many vegetable farmers, even if they don't know it. That trouble may be in the form of reduced yields, excessive runoff and soil erosion, or an increase in root disease. Just because compaction is out of sight doesn't mean it should be out of mind.

Understanding compaction. Soil is a mixture of minerals, organic matter, and pore space. The mineral particles are a combination of sand, silt, and clay (the soil's texture). These are rather loosely arranged, surrounded by spaces that contain air and water. Soil compaction occurs when the soil's particles are pressed together, limiting the space that's available for air and water.

The amount of water in the pore space has a significant effect on how easily soil can be compacted. In a relatively dry soil, there is more friction between the soil particles, so they resist compaction. When sufficient water is present, it acts as a lubricant between the particles, and that makes the soil easier to compact. But water cannot be compressed, so once the soil pore spaces are mostly filled with water, it helps soil resist compaction. The result is that neither a dry soil nor a very wet soil will compact as readily as a moist soil.

Soil texture can also influence the compaction potential of a soil. Particles of similar size will compact less than a mixture of particle sizes, because smaller particles can fill in the pore spaces between larger particles. Thus, soils with a diverse mix of sand, silt, and clay are relatively susceptible to compaction, compared to soils that are dominated by one class of particle size.

Soil structure (the tilth of the soil) also plays a role in compaction, or its prevention. Soils with high organic matter content and good aggregation tend to resist compaction better than soils with low organic matter. Excessive tillage can promote compaction by breaking down soil aggregates and speeding up the decomposition of soil organic matter.

Types of compaction. Surface compaction occurs in the zone of tillage, and subsurface compaction is in the zone below the depth of normal tillage. Surface compaction, including soil crusting, can usually be alleviated with typical tillage operations, but subsurface compaction will remain in place unless special steps are taken to fracture or cut through the compacted soil underneath the tillage zone.

Causes of compaction. A widespread cause of soil compaction is farm vehicle traffic, especially heavy equipment with poor weight distribution. It is common knowledge that compaction from vehicles is made worse when farm operations are conducted before the soil has adequately dried. However, it's also well known that farming must go on, and sometimes that means getting your work done even if the conditions are not optimal.

Tillage is another cause of compaction, especially with implements that shear the soil, such as moldboard plows, disks, and heavy sweeps. When operated repeatedly at the same depth, tillage implements orient soil particles in the same direction, creating a layer of compacted soil known as a tillage pan or plow pan. As with vehicle compaction, the potential to create a tillage pan is greater when the soil is moist than when it's dry.

Symptoms of compaction. The ultimate indicator of compaction is a reduction in yield, but many factors can contribute to that. More direct signs of compaction are: standing water in the field, poor water infiltration and runoff, a wheel-track pattern that is visible in crop growth, difficulty pulling implements through the soil without additional power, and poor root growth that reduces water and nutrient uptake, causing leaf discoloration and/or premature drought stress. Often, such symptoms will be expressed in one field but not another, or in portion of a field because of variability in soil characteristics that affect compaction.



Standing water in a field can be a sign of subsurface compaction causing poor drainage

Measuring compaction. Many growers have seen evidence of a compaction problem, but have yet to prove it. The way to measure both the extent and depth of subsurface compaction is with a penetrometer, which is a soil compaction meter. By pushing the penetrometer into the soil at a number of locations, you get a reading of the pressure required to do so. Having that data helps with decisions about whether to take steps to alleviate compaction, such as subsoiling. Penetrometers cost about \$200, and are available from several companies (Gempler's (www.gemplers.com, 800-382-8473) and Forestry Suppliers (www.forestry-suppliers.com, 800-647-5368, etc.)



A penetrometer measures compaction in pounds per square inch of pressure. If it takes more than 300 psi to push through a compacted layer, it is unlikely that crop roots will be able to grow through the layer.

Dealing with compaction. The best approach to compaction is to avoid it in the first place. Do not work soils that are too wet. Before conducting tillage, check out the soil's moisture at the depth of tillage operation, not at the soil surface. If the soil can be pressed into a ball that holds its shape, it is too wet for tillage.

Try to choose and use tillage implements in a manner that will reduce the formation of a tillage pan. Moldboard plows and heavy disks, especially those that are widely offset, are known to

cause tillage pans. Large, rigid sweeps commonly found on some field cultivators can have a similar effect. Operating these kinds of tools at the same depth for a few years without varying tillage equipment or depth will cause a compacted layer in the soil.

Deep tillage with a subsoiler is one way to break up subsurface compacted layers. This requires relatively powerful tractors that are not available to some growers, and is not always effective, especially in the long term, if other practices are not put into place to manage compaction. When subsoiling, it is important to know the exact depth of the compacted layer, so you are sure to set the subsoiler below it.



Depending on soil type, depth of tillage, and severity of compaction, it can require anywhere from 25 to 45 horsepower per shank to pull a subsoiler.

A new approach to tillage called Deep Zone Tillage aims to break up compacted layers while only disturbing about 1/3 of the soil surface. The units cut strips in surface residues, create 'slots' for plant roots directly under the rows, and leave the soil surface between rows undisturbed. For more information see the reduced tillage in vegetables web site at Cornell University:

<http://www.hort.cornell.edu/reducedtillage/>



This 2-row deep zone strip tiller is being used in winter-killed oats. To succeed with zone tillage, growers must have planters and weed control systems in place that are appropriate for the level of surface residue.

Taking land out of vegetable production for 2 to 3 years in order to grow alfalfa, a deep-rooted perennial, can be effective, but may not be an economically viable option for vegetable farmers. Be aware that it can sometimes be difficult to establish a healthy alfalfa crop on compacted soils.

Other, shorter-lived cover crops are also known to help reduce compaction, including deep-rooted sweet clover. Research has shown that sorghum-Sudangrass and, somewhat surprisingly, perennial ryegrass are also good cover crops for alleviating compaction.

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