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Plant Materials

Miscellaneous Note No. 1

Managing Soil Compaction: Some Considerations

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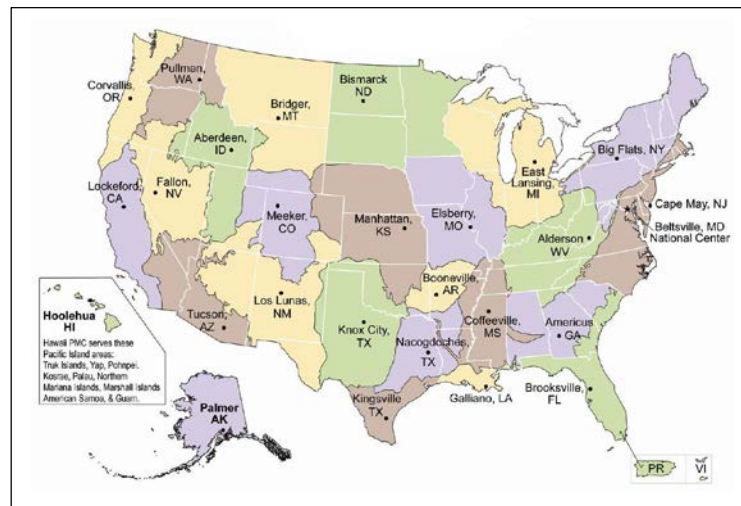
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Preface

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Plant Materials Program has been involved in the collection, evaluation, selection, increase, and release of conservation plants for more than 75 years. This publication was prepared to provide information needed by conservationists, producers, or consultants to help make decisions regarding the use of millets for use in conservation practices, especially those focused on making use of marginal cropland, nutrient poor and water-stressed soils, periodically flooded soils, and areas needing cover crops or wildlife restoration. With future weather and climate conditions becoming more variable, less predictable, and more extreme, it is useful for growers to have a wide variety of agronomic options that include the use of millets. Due to their long history of cultivation across the world and their wide adaptability to a variety of environmental conditions, millets as a group seem uniquely positioned to be one of the more resilient crops available to farmers.

For additional information on specific species of plants mentioned in this publication, please see the USDA PLANTS database at: (<http://plants.usda.gov/java/>) or contact the nearest Plant Materials Center or plant materials specialist (<http://plant-materials.nrcs.usda.gov/contact/>) and/or the Land Grant Universities that serves the State. For specific information on soils and soil health, please see USDA NRCS soils website at: (<http://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/>). Also, see technical resources on the National Plant Materials Program Web site at: (<http://www.plant-materials.nrcs.usda.gov/>).

Location and service areas of Plant Materials centers



Service area of the Plant Materials Program Northeast Region



Acknowledgements

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Managing Soil Compaction: Some Considerations

As tractor and equipment weight continue to increase, as weather fluctuates between wetter-wets and dryer-drys, and as rates of carbon in the soil continue to decline, we should expect to see an increase in production problems caused by soil compaction. Once established, soil compaction is not easy to alleviate.

Most often farmers and natural resource managers will try to fix compaction or ruts in a field through deep tillage with a disk chisel, subsoiler (disk ripper), or ripper. This method of soil management penetrates soil below normal tillage depths and breaks up compacted layers, temporarily “fluffs” it, and increases water infiltration without inverting the soil.

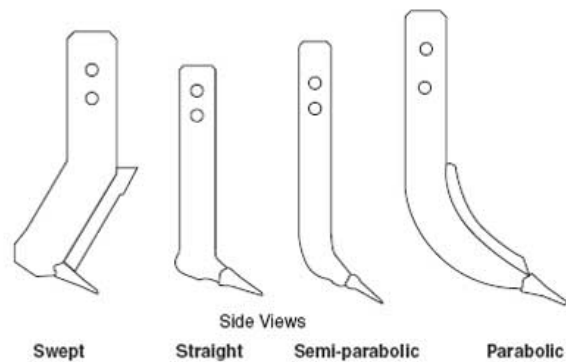
The problem is, there are many factors that effect soil compaction, and subsoiling does not correct them all. In fact in some instances, if the ripper is used incorrectly it can *increase* compaction, not alleviate it. If the shank of the ripper is deeper than 2” below the compacted layer, then subsoiling can increase compaction because it was too deep to shatter the compacted layer. Also, there are differences in tillage effectiveness depending on the type of soil that is worked. Subsoiling is more effective on sandier topsoil, but is less effective on heavier topsoil with more clay. For heavier soils, more tillage passes are required, and still yields may be lower even after tillage. Another factor to consider besides depth of tillage and soil type is the speed of the farm equipment. In subsoiling/ripping it is important to use moderate speed. If the speed is too fast, too much residue can be brought to the surface; too slow, and the shanks may not rip properly. Additionally, the size and type of the farm equipment and tires play a major role in determining axle load. Generally, if the axle load is kept under 10 tons, any negative impacts due to traffic will be kept to the top 6–10 inches, and not cause irreversible damage to the deeper subsoil layers (DeJong Hughes, 2009; Duiker, 2004). Lastly, some farmers will use the subsoiler for multiple passes, or during both fall and spring, instead of opting for less frequent use. Using deep tillage too frequently (more than once a year) can result in worse compaction issues.

The language used to describe the practice of subsoiling or ripping can be just as challenging as its proper implementation. Manufacturers of tillage equipment are sometimes inconsistent when defining the form and function of tillage equipment like disk chisels and disk rippers with regard to subsoiling and ripping. In many cases, the size, length, and tip of the shanks or the angle of the coulters or disks determines whether you are actually practicing reduced tillage, minimum tillage, or are subsoiling (building) or inverting (destroying) soil. Many of these practices are used synonymously under a broader umbrella term like “vertical tillage”, which is a practice that shreds and sizes surface residue through faster equipment speeds, and may or may not necessarily use a vertical shank at all.

So in summary, deep ripping with a “soil builder” may not always be good for soil health or for farmers’ yields. Subsoiling should be seen as another potential tool in the toolbox that requires good management practices. If done wrong, it can increase rather than decrease soil compaction. **Mechanical means of fixing compaction will be optimized if used in combination with continued deep-rooted cover crop rotations.**

For More Information:

- The USDA Forest Service factsheet comparing designs and functions of subsoiling shanks: <http://www.fs.fed.us/t-d/pubs/htmlpubs/htm08342828/page03.htm>
- 2 Penn State factsheets on compaction: <http://extension.psu.edu/plants/crops/soil-management/soil-compaction/effects-of-soil-compaction>; and: <http://extension.psu.edu/plants/crops/soil-management/soil-compaction/avoiding-soil-compaction>
- For a historical perspective of deep tillage in the Midwest try: <http://www.ars.usda.gov/sp2UserFiles/Place/50701000/cswq-t3323-larson.pdf>. Much of its analysis still holds true today. Also visit farmer internet chat boards like “AgTalk” to follow the latest anecdotal results of subsoiling: <http://talk.newagtalk.com/forums/thread-view.asp?tid=35116&DisplayType=nested>



Picture courtesy USDA-USFS Technology and Development Program. The illustration shows the differences in ripper shank design. Each design will result in a different subsoiling performance.



Photo showing tillage cover crops that can help reduce compaction including (from left to right) purple top turnip, forage chicory, and tillage radish (planted late fall). The red arrow indicates the minimizing effect severe soil compaction can have on subsoiling cover crops. This tillage radish was ineffective at soil compaction >300 psi.

For more information, contact: NJPMC, (609) 465-5901

Pros to Subsoiling:

- Creates vertical passages that increase the amount of the soil profile your roots will have access to
- Increased root development, growth, and access to moisture
- Can help crops withstand short-term drought conditions (Raper et al., 2005)
- Less CO² loss than other forms of tillage

Cons to Subsoiling:

- Yield responses to subsoiling has been variable; with positive, neutral, and negative results
- Can be easily done too deep and/or too fast, which can waste energy and increase cost
- Can easily disturb and bury too much residue
- Is a short term fix that ultimately does not improve soil structure
- If deep tillage is not used in combination with a change in management practices, soils will become recompact and left in a worse condition within several years (Kooistra and Boersma, 1994).
- Power requirements for subsoiling with large equipment does not reduce cultivation costs (Peigne et al., 2007)

Dos & Don'ts:

- Site-specific subsoiling to only the depth needed—grab a shovel and find out how deep the compaction layer is, and only rip to 1” below that depth
- Subsoil when conditions are dry so as not to increase compaction (soil moisture should be less than 30% of field capacity at maximum depth of tillage)
- Run equipment at moderate speeds
- Only run one pass through the field
- Minimize equipment traffic
- Reduce axle load, inflate tires properly

References

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