6-19-2006

Field soil variability and its impact on crop stand uniformity

Mahdi Al-Kaisi
Iowa State University, malkaisi@iastate.edu

H. Mark Hanna
Iowa State University, hmhanna@iastate.edu

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Abstract
Soil variability plays a significant role in crop performance, especially in dry conditions, where spatial variability of soil texture can show the moisture shortage effect on plant stand variability across the field. Generally, soil is not uniform and immense spatial soil texture variability can be noticed across fields (see the June 12, 2006, ICM article (pages 169-171), What's the yield effect of uneven corn heights?). Soil texture is a key factor in influencing soil's water-holding capacity. Coarse-textured soils have a lower moisture-holding capacity due to high porosity and ability to drain excess water quicker than fine-textured soils.

Keywords
Agronomy, Agricultural and Biosystems Engineering

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences | Bioresource and Agricultural Engineering

Soils

Field soil variability and its impact on crop stand uniformity

by Mahdi Al-Kaisi, Department of Agronomy, and
Mark Hanna, Department of Agricultural and Biosystems Engineering

Soil variability plays a significant role in crop performance, especially in dry conditions, where spatial variability of soil texture can show the moisture shortage effect on plant stand variability across the field. Generally, soil is not uniform and immense spatial soil texture variability can be noticed across fields (see the June 12, 2006, *ICM* article (pages 169–171), "What's the yield effect of uneven corn heights?"). Soil texture is a key factor in influencing soil's water-holding capacity. Coarse-textured soils have a lower moisture-holding capacity due to high porosity and ability to drain excess water quicker than fine-textured soils. On the other hand, fine-textured soils, which are prevalent in most of Iowa, have varying percentages of silt and clay as the main components. Therefore, these fine-textured soils have a higher moisture-holding capacity.

Changes in soil texture across a field affect moisture availability, which in turn affects the crop stand. In addition, changes in soil texture and soil moisture can significantly impact soil temperature. Soil texture, soil drainage class, and tillage system can have an impact on soil temperature. One of the challenges of planting poorly drained soils and in no-tillage systems is a cool soil temperature early in the season, which may lead to a poor stand. Therefore, the latest field observations on corn stand variability in some areas in the state may be attributed to soil conditions and management practices early in the season, in addition to other factors. Conservation systems such as strip-tillage or residue management using row cleaners on a planter are proven practices to minimize cool soil temperature effects on corn germination in poorly drained soils early in the season.

Dry soil moisture conditions in the top foot of soil have affected crop performance in some areas of the state where marginal soil conditions under extensive tillage along with lack of precipitation were dominant. These dry soil conditions can be prevalent in areas in the state where soil organic matter is low and soil texture is fine. Organic matter contributes significantly to improving soil moisture-holding capacity by improving soil structure and water infiltration.

Uneven corn stand in southeast Iowa, June 2006. ***(Virgil Schmitt)***

Other confounding factors are related to management practices during field preparation and planting. Some corn plants showing a delay in growth can be explained by improper planting depth, soil surface compaction or side-wall compaction due to planting in wet soil conditions, and nutrient deficiencies such as phosphorus or potassium. Seedbed preparation along with equipment settings, whether for tillage or planting, can have a combined effect on plant performance. It is very difficult to isolate the exact cause of poor corn performance when soil conditions and management practices were not at their best. While scouting fields and evaluating soil conditions, producers and others need to check soil moisture at the seedbed below the soil surface because the nodal root system gets established at a depth of ¾ to 1" deep under normal conditions. Adequate soil moisture, less compacted seedbed or side-wall compaction, and adequate nutrient availability can provide a good growth environment for these root systems.

Even though wide ranges of soil conditions work together on influencing crop performance, soil compaction can cause significant damage to early growth and subsequent yields. The most effective way to minimize soil compaction is to first avoid field operations when soil moisture is at or near field capacity. Soil compaction will be less severe when tillage, fertilizer application, and planting operations occur when the field is drier than field capacity. Soil moisture can be determined using a “hand ball test” or observing a “soil ribbon test.” Second, properly adjust tire air pressure. Larger tires with lower air pressure allow for better flotation and reduce the load on the soil surface. Additionally, using larger tires that are properly inflated increases the “footprint” on the soil. Third, use the same wheel tracks to minimize the amount of land traveled across the field. Most damage occurs with the first pass of the implement. Using controlled traffic patterns can be done effectively by using implements that are the same width for seedbed preparation, planting, row cultivation, spraying, and harvesting.

Soil compaction can be a serious problem for Iowa farmers, but with proper management, compaction can be minimized. Remember to put a hold on soil tillage operations until soil conditions are drier than field capacity and look into the benefits of conservation tillage systems. The photo at the right shows the impact of different levels of soil compaction on plant growth, where soil bulk density increased with the increase of soil compaction. This example demonstrates the impact of soil compaction effect on root growth and plant stand variability.

Plant symptoms can be significantly exacerbated by poor management decisions early in the season. A delay in plant performance can be very costly and plants may never fully recover from early-season setbacks, causing significant yield losses (see the June 12, 2006, *ICM* article (pages 169–171), “What’s the yield effect of uneven corn heights?”). The lesson to learn from such problems is to pay attention to the field condition and make correct decisions on when to enter the field and whether the soil condition is ready to till or plant. At this time in the growing season with a soil moisture shortage in some areas in the state, row cultivation can accelerate moisture loss.

Effect of soil compaction on root and seedling growth at three different soil bulk densities: Low, 0.7 g/cm^3; Medium, 1.1 g/cm^3; High, 1.6 g/cm^3. *(Stephanie Nelson, Honors Program project)*.

Top 10 Reasons to Avoid Soil Compaction

1. Causes nutrient deficiencies
2. Reduces crop productivity
3. Restricts root development
4. Reduces soil aeration
5. Decreases soil available water
6. Reduces infiltration rate
7. Increases bulk density
8. Increases sediment and nutrient losses
9. Increases surface runoff
10. Damages soil structure

Mahdi Al-Kaisi is an assistant professor in agronomy with research and extension responsibilities in soil management and environmental soil science. Mark Hanna is an extension agricultural engineer in agricultural and biosystems engineering with responsibilities in field machinery.