# BASIC CONSIDERATIONS OF SOIL COMPACTION, TILLAGE, AND CROP PROBLEMS

Gary C. Steinhardt
Agronomy Department
Purdue University

Soil compaction is one of the most challenging variables in crop production in the Midwest. It affects early crop growth and can lead to yield reductions. The most unusual aspect of soil compaction is the variety of crop symptoms that can develop.

Few absolute answers are available on the topic of soil compaction. Our research is limited to the effects of different soil conditions on yields and some early symptoms that can be caused by soil compaction.

We have developed three principles that appear to work well for Indiana soil conditions. First we have shown that the effects of soil compaction can affect yield for more than one growing season. Table 1 contains the results of an experiment at the Purdue Agronomy Farm with severe subsoil compaction. The density of the top three inches of the subsoil was increased only once in 1979, from 1.6-1.7 $g/cm^3$ to 1.7-1.8 $g/cm^3$ by driving on the subsoil after removal of the topsoil. Yield reductions the first two years of the study were consistent but caused by very different conditions. The first year excess water was a problem even on the well tilled plot. The second year was unusually hot and dry and the yield reductions were related to those conditions. In 1981 the growing season was more normal and compaction continued to affect yields but not as consistently as before. There was considerable variability within the compacted plots in plant height and appearance. The variability between plots and within an individual plot increased in 1982 and 1983; although yield averages were lower in compacted plots the results were not statistically significant. This illustrates a second principle that at least with silt loam and silty clay loam soils compaction appears to improve with time. Table 2 demonstrates the same point with surface compaction. The surface compaction was caused by 16 trips with a two wheel drive tractor under slightly moist conditions. The measurable effects of soil compaction on yield remained for two years. This principle does not apply equally to all soils and climate conditions however. Table 3 is a subsoil compaction experiment at the Pinney-Purdue Agricultural Center in northwest Indiana. It is similar to the experiment at the Agronomy Farm except that the soil is a well drained sandy loam. Although we obtained excellent yields in 1982 with favorable weather conditions, yields for 1983 and 1984 with more unusual conditions were lower even though compaction was not increased in any manner. Similar reductions appear likely for 1985 with particularly dry conditions. Sandy soils do not appear to come back in the same manner as the silt loam soils.

Table 3 also demonstrates a very important third principle about soil compaction. The effects of soil compaction on yields are strongly

related to environmental conditions. With adequate and timely rainfall soil compaction did not present a problem. Yield or crop affects on compacted soils are difficult to predict. In a given year the effects may or may not be present. As with Table 3 we set near record yield levels one year and then had yield reductions caused by compaction which had been created a year or two previous. In a field situation this would be extremely difficult to explain.

There are other problems that can be caused by soil compaction that may not result in yield loss but are troublesome nonetheless. These are crop problems that show up early in the season. I have observed these in our plots with such compaction problems as variable growth rate, fertility deficiencies, slow emergence and soil compaction induced herbicide injury. Some soils can be compacted quite easily. Figure 1 shows a relationship between soil moisture content and compaction resulting from a 15 $lb/in^2$ load for a typical 2% organic matter silt loam. Note that the range of water content for maximum compaction is fairly broad and occurs at moisture contents which are typical for spring tillage. As a result operations in the spring can develop soil densities which could influence plant growth.

Table 4 contains results of a greenhouse experiment that demonstrated one of the problems that can occur. This shows the effects of higher soil density on seedling injury from residual herbicide. Note a residual rate of herbicide that did little or no damage without compaction can appear to cause as much injury as twice as much of the chemical when the seedling is growing in compacted soil. Although this experiment used only one compound we feel from field observations that several other commonly used herbicides will be similarly affected by soil compaction.

Easy answers are difficult to find when evaluating the effects of soil compaction. The most important point is to be aware that soil compaction can affect crop performance and that it should be a consideration in troubleshooting.

Table 1. Results of Subsoil Compaction Experiment at the Purdue Agronomy Farm, West Lafayette, Indiana 1979-83.

| Year | Soil Condition | Corn Yield (Bu/A) |
|---|---|---|
| 1979 | Uncompacted | 200** |
| | Compacted | 99 |
| 1980 | Uncompacted | 106** |
| | Compacted | 82 |
| 1981 | Uncompacted | 174* |
| | Compacted | 158 |

** = Statistically significant at 0.01
* = Statistically significant at 0.05

Table 2. Results of Surface Compaction Experiment at the Purdue Agronomy Farm, West Lafayette, Indiana 1982-84.

| Year | Previous Cover 1981/Soil Condition | | Corn Yield Bu/A |
|---|---|---|---|
| 1982 | Soybeans | Not Compacted | 159** |
| | Soybeans | Compacted 1982 | 129 |
| 1983 | Soybeans | Not Compacted | 107** |
| | Soybeans | Compacted 1982 | 92 |
| 1984 | Soybeans | Not Compacted | 157 ns |
| | Soybeans | Compacted 1982 | 158 |

** = Statistically significant at 0.01

Table 3. Results of Subsoil Compaction Experiment at Pinney-Purdue Farm, Wanatah, Indiana 1982-84.

| Year | Soil Condition | Corn Yield (Bu/A) |
|---|---|---|
| 1982 | Uncompacted | 151 ns |
| | Compacted | 147 |
| 1983 | Uncompacted | 92** |
| | Compactd | 76 |
| 1984 | Uncompacted | 112** |
| | Compacted | 94 |

** = Statistically significant at 0.01

Table 4. The effect of surface compaction and trifluralin on growth characteristics of corn seedlings.

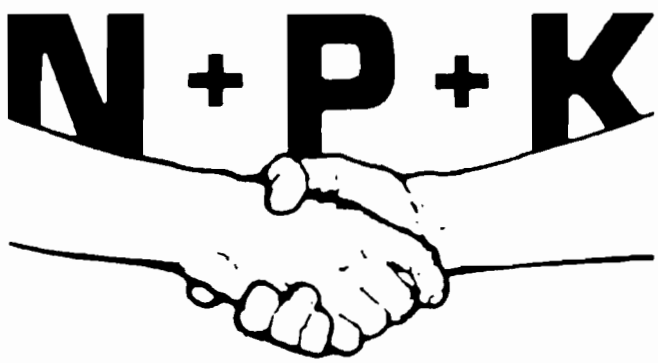
| Bulk Density | Growth characteristics of corn<br>Trifluralin rate (ppm)* | | |
|---|---|---|---|
| | 0.0 | 0.125 | 0.250 |
| ($g/cm^2$) | ----------(% of control)---------- | | |
| | Degree of root tip swelling | | |
| 1.10 | 0 a | 22 c | 48 de |
| 1.50 | 0 a | 22 c | 52 e |
| 1.66 | 16 b | 44 d | 82 f |
| | Number of secondary roots | | |
| 1.10 | 100 a | 70 bc | 54 d |
| 1.50 | 77 b | 64 c | 49 d |
| 1.66 | 66 c | 54 d | 39 e |
| | Length of secondary roots | | |
| 1.10 | 100 a | 68 b | 50 c |
| 1.50 | 95 a | 64 b | 48 c |
| 1.66 | 62 b | 48 c | 29 d |

* = Means within a measurement set followed by the same letter are not significantly different at the 1% level according to Newman-Keuls sequential range test.

Bulletin 729

# PROCEEDINGS

## OF THE FIFTEENTH
## NORTH CENTRAL EXTENSION-INDUSTRY
## SOIL FERTILITY WORKSHOP

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