4-1984

Causes of Soil Compaction and Ways to Minimize Them

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5-17-84

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Soil Science News & Views

Vol. 5, No.4 April, 1984

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In order for a soil to become compacted, two conditions must be present, pressure and a soil that will compact. Different soils have different compaction characteristics. Sandy loam soils compact most readily; however, most soils with a high percentage of sand compact easily. Silt loam soils are more resistant to compaction, but they too are easily compacted when wet. When silt loam soils are not wet, it requires high pressure to compact them. When the soil is wet, each particle is lubricated and less pressure is required to compact the soil. Clayey soils can be compacted; but, as they dry and cracking takes place, they loosen themselves.

In addition to a soil that will compact, sufficient pressure must be applied to the soil to cause compaction. Discs probably apply more pressure on the soil than any other tillage equipment. Large discs press on the soil at a pressure of several hundred pounds per square inch. Discing a wet soil will compact it more than any other operation. A hardpan formed by discing is usually 4 to 8 inches deep. Moldboard plowing can also cause compaction. This is not caused by the plow but by the wheel of the tractor running in the open furrow. If this pan exists, it is usually 8 to 12 inches deep. Excess traffic by any type of equipment can cause severe compaction in a subsurface layer sometimes called a traffic pan. This is very common at field entrances and areas in the field where equipment is turned.

Effect of Compaction on Plant Growth

Compaction first affects root growth. It reduces the number of pores through which roots can grow and increases the amount of pressure a root must exert to penetrate the soil. As soils become compacted, root growth is reduced. The greater the compaction, the more the root growth is reduced. However, root growth and yield are not always closely related. A large reduction in root growth must take place in most crops to reduce yields; however, severe compaction may reduce yields as much as 30 to 40%. The effect of compaction on yield will also vary greatly with the yearly weather conditions. Moderate compaction would be expected to reduce yields only to 5-15% with tobacco and 0 to 10% with corn and soybeans. Tobacco is more affected by compaction than corn and soybeans due to

(1) a large tap root making it difficult to penetrate pans, (2) greater sensitivity to wetness, and (3) the soil usually being tilled excessively. Compacted soils become waterlogged easier.

Detecting Pans

Usually compaction occurs only in a specific layer in the soil. Determining the presence and location of this layer in the field is the first step in solving the problem. You can make a testing rod by welding a handle to a 2 1/2 foot piece of half inch steel rod and sharpening the end. Tests with a rod should be made when the soil moisture is correct for plowing. Low soil moisture will make the pan harder to penetrate with the rod and make the problem seem more severe. To check fields, slowly push the rod into the soil at a constant rate. The force required to push the rod into the soil will be fairly constant until a compacted zone is reached. At this point, more force will be required to penetrate the compacted layer. After the rod passes through the compacted layer, the pressure required to push the rod will be noticeably reduced. The probe should be used at several locations across each field and several times at each location. Compacted layers can also be identified by digging a hole and looking at the soil and plant roots. If tap roots turn abruptly or if feeder roots are found matted and flattened at a specific depth, a pan is likely to be present.

Correcting and Preventing Pans

Deep moldboard plowing or chisel plowing can be used to effectively remove pans. Chisel plows require less power than moldboard plows. If a compacted layer is deeper than 12 inches, subsoiling is the best way to shatter it. Subsoiling requires a large amount of power and is a waste of time if the pan is wet or if no pan is present. Discing the soil when wet can partially or totally reestablish the pan you have just broken by subsoiling or chisel plowing. Freezing and thawing is helpful in breaking up a pan but is mainly effective only in the top few inches of the soil.

The best way to handle a traffic pan is to prevent it. There are a number of practices that are helpful in this regard. Reduce trips over the field by eliminating unnecessary operations. Ask yourself if each trip is necessary, since it may be compacting the soil, wasting energy and costing money. Do not work the soil wet. This is probably the most destructive practice which can be used on the silt loam soils of Kentucky. This is especially true with discing wet soil. Winter cover crops can also be of some help in improving soil structure.

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