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Correction and Prevention of Soil Compaction

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Introduction

Soil can be compacted by both natural and man made forces. The most common cause results from tillage practices. These man induced compacted layers are often called a traffic pan, disc pan, plow pan, wheel compaction, hard pan, etc. Some compaction occurs in most soils that are tilled. If compaction is severe enough, it may reduce plant growth and yield. Soil compaction can be corrected by subsoiling and deep plowing but they are expensive methods. Soil compaction may not be a problem if one understands compaction, its effects, and how to prevent it.

Principles of Compaction

In order to compact a soil, two ingredients must be present: (1) pressure and (2) a soil that will compact. Soils have different compaction characteristics. Sandy loam soils compact most readily; however, most soils with a high percent of sand compact easily. Silt loams can also compact; but, they are much more easily compacted when they are wet. In order to compact a silt loam soil, all the soil particles must be pushed together. When the soils are moist to dry, it requires very high amounts of pressure to do this. When the soil is wet, each particle is lubricated and less pressure is required to compact the soil.

Kentucky has primarily silt loam surface soils. They compact easily when tilled too wet. In the words of an old timer, "when you work soil too wet, you will pay for it sooner of later". When these soils are tilled at the proper moisture, they exhibit resistance to compaction.

Clay soils naturally compact themselves as they swell when they are wetted. As they dry and cracking takes place, they "subsoil" themselves. Although they can be compacted by machinery, this natural process is effective in correcting it. Occasionally a crop on a clay soil will respond to subsoiling. This is probably due to greater water infiltration, less crusting, or some effect other than correction of a compacted layer.

In addition to a soil that will compact, sufficient pressure must be applied to the soil to get it to compact. This pressure is often exerted from the heavy equipment used in farming operations. This type of compaction is restricted to the top few inches and can be easily removed by further tillage. Discs probably apply more pressure on the soil than any other piece of equipment. Large discs press on the soil at a pressure of several hundred pounds per square inch. Discing wet soil will compact soils more than any other method. In fact, if one were trying to compact the soil, this would be an excellent method. A pan 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 behind the last round with the plow. If this pan exists, it will usually be 8 to 12 inches deep. Excess traffic by any type of equipment can cause severe compaction. This is very common at field entrances and areas in the field where equipment is turned.

Effect of Compaction on the Plant

Almost all soils which are being row cropped have been compacted to some extent. 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 in order to penetrate the soil. As soils become compacted, root growth is reduced. The greater the compaction, the more the root growth is reduced. Most of the time compaction is confined to a specific layer in the soil. The layer will probably be 2 to 6 inches thick and occur just below the depth of the discing or plowing or just below the soil surface if surface traffic has been heavy. In this case, the root density will be near normal above the compacted zone and low within it. As roots grow through the compaction zone, the root density will increase below it.

Root growth and yield are not 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 vary greatly with the yearly weather conditions. Moderate compaction would only be expected to reduce yield 0 to 10% on corn and soybeans and 5-15% with tobacco. Tobacco has a large tap root which must have large pores in the soil in order to penetrate. As soil is compacted the amount of air in the soil is reduced and the soil can become water logged much easier. This means that the soil has less oxygen for root metabolism, especially during prolonged wet periods. Tobacco is very sensitive to low soil oxygen. All of these factors make tobacco more sensitive to compaction than any other crop commonly grown in Kentucky.

Detecting Pans

Determining the presence and location of a hard pan in the field is the first step in solving the problem. A soil penetrometer is a good tool for this job. Pans causing the penetrometer to read above 300 pounds per square inch may reduce crop yields. Roots are rarely found in soils with penetrometer readings above 500 p.s.i.

If you do not have a penetrometer, you can make a testing rod by welding a handle to a 2½ foot piece of half inch steel rod and sharpening the end. A 175 pound man can exert 300-350 p.s.i. on a half inch rod pressed into the soil. Tests with a penetrometer or 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 your fields, slowly push the rod into the soil at a constant rate. The force required to move 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.

To get an idea of the depth, thickness, strength of the pan, and percentage of the field affected, the probe should be used at several locations across each field and several times at each location. A long soil sampler can also be used in place of the rod. In fact, one trip over the field on a combination soil sampling and compaction survey works quite well.

Ends or sides of the field which are used for turning, should be carefully checked. Traffic is two to three times greater in these areas than in other parts of the field.

Hard pans 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 a pan is likely. Close examination of the soil will show platy or massive structure with soil particles pressed close together. This is in contrast to the more friable and granular like structure found above and below the pan. Parts of Kentucky have soil with fragipans. Fragipans are usually 18 to 36 inches below the soil surface, are usually well over a foot thick and are formed by natural means. The structure of these pans are also massive but can be distinguished from a traffic pan by depth, thickness, and appearance.

Plants growing on a soil with a substantial pan will show early drough stress.

Correcting Pans

Deep moldboard plowing can effectively remove compaction in the soil if the depth to the pan is shallow. However, deep plowing can turn up undesirable subsoil and increase the risk of erosion on sloping land.

If the pan is not deeper than 12 inches, chisel plowing can be used to effectively remove pans. Chisel plows require less power than moldboard plows. However, their depth of tillage is deceptive. Because they fluff the soil, it appears they are operating several inches deeper than the tillage is really taking place.

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 it is only profitable when a definite pan exists. Remember that subsoiling will not increase yields unless you have a compaction problem. Subsoiling is a waste of time if the pan is wet. Subsoiling across the rows is considered by many to be more effective than subsoiling with the rows. If the pan is dry, the pan will shatter on both sides of the shank. When subsoiling in the fall, avoid discing afterwards, simply let the field stand until spring just as the subsoiler left it. The less the soil is disturbed and the fewer trips over with machinery, the more lasting will be the effects of subsoiling. Discing the soil wet after subsoiling can partially or totally reestablish the pan you have just destroyed by subsoiling or chisel plowing.

For soils that are easily recompacted after primary tilling, in-row subsoiling planters has definite advantages. The in-row subsoiling planter, subsoils as it plants and gives the plant roots a straight shot through the traffic pan. Except for a very few sandy soils, Kentucky does not have such susceptible soils. Present research has not shown this tool to be an advantage for most Kentucky soils.

Freezing and thawing of the soil has a corrective effect on compaction. This effect is helpful but mainly restricted to the top few inches of the soil and has not been found to correct plow pans or disc pans below six inches.

<u>Preventing Pans</u>

The best way to handle a traffic pan is to prevent it. There are a number of practices that are helpful, such as:

1) 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. Combine as many operations as possible to reduce trips across the field.

2) Do not work the soil wet. This is probably the most destructive practice which can be used on the silt-silt loam soils of Kentucky. This is especially true with discing wet soil.

3) Hold discing to a minimum. This is one of the most, if not the most, compacting tool you own. It is especially destructive on wet soils.

4) Winter cover crops such as legumes and grain crops can be of some help in improving soil structure by root action as well as the addition or organic matter.

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