# INFLUENCE OF SOIL COMPACTION AND TILLAGE ON POTATO PRODUCTION

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Compaction is any process that destroys soil structure and results in a denser soil with less pore space to hold water and air. Most compaction is associated with tillage operations and tire compression, but even grazing animals can cause significant compaction. In fact, a force as low as 4 pounds per square inch (psi) is enough to cause significant soil compaction. Pressure on the soil surface from the edge of a tractor tire can exceed 25 psi. Wet soils, particularly those low in organic matter, are most vulnerable to compaction. Sandy loam and clay soil textures are the most susceptible to compaction, followed by loam, with sands being the least susceptible. Sandy loam soils are common in the potato production regions of Idaho and compaction may be one of the most unrecognized factors that limit potato yield and quality in these soils.

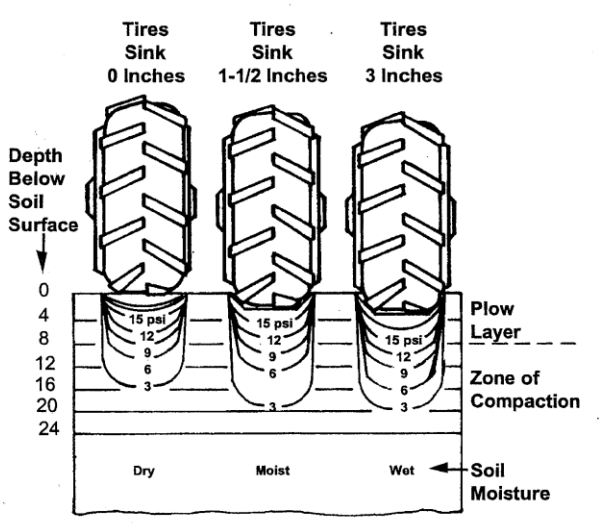


Figure 1. Relationship between soil moisture, tire pressure and compaction (from Daum and Shipp).

Compaction can occur at different depths within the soil profile. Surface compaction occurs near the soil surface down to the depth of tillage. The extent of surface compaction is determined by the soil texture and moisture and the amount of force applied by the equipment. Soils compacted in the surface layer can usually be loosened by tillage operations, freeze-thaw cycles and growth of some deep-rooted crops (such as alfalfa). Plow pan or subsoil compaction occurs in a narrow zone just below the depth of normal tillage operations. It is most common when the depth of tillage is the same every year. Subsoil compaction is difficult to treat because it is below the zone of normal

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tillage. The soil moisture and texture and the total axle weight of equipment will determine the extent of subsoil compaction. Deep ripping can alleviate some of the effect of compaction, but this practice is costly and does not completely overcome this problem. Regular tillage operations are also more costly in compacted soils, due to increased fuel expenditures for greater horsepower requirements.

Soil compaction affects plant growth in a number of complex ways. Air and water movement are restricted, limiting their availability to plants. Roots do not develop or penetrate the soil as well resulting in a much restricted and shallow root system. The plant also has to expend more energy on root growth, reducing the availability of energy for other growth processes. As a result, plants will generally be stunted, and stress due to moisture and nutrient deficiencies may occur more readily. Soil compaction also reduces water infiltration resulting in poor soil moisture uniformity. Poor infiltration also results in soil erosion and movement of mobile nutrient salts and pesticides resulting in poor availability on the hills and excess in low spots. Furthermore, low spots in the field tend to stay saturated longer resulting in oxygen deficiency and microbial denitrification loss of nitrogen and decomposition of pesticides with nitrate functional groups. These saturated soils also tend to stay cooler longer resulting in further reductions in root growth, as well as reduced nutrient diffusion and mineralization rates and increased incidence of fungal diseases.

## IMPACT OF COMPACTION ON POTATOES

Potatoes have a very fine, branching root system that is especially susceptible to damage due to compaction. Under good soil conditions roots grow at a rate of about ½ inch per day during the first three weeks after emergence (Stalham, 2002). Compaction greatly restricts both the total root mass and the maximum depth of rooting. The result is a delay in initial emergence, slower canopy development and reduced yields. Compaction within the shallow zone where roots initially form has been shown to be more damaging than deep compaction.

There have been several studies that have evaluated the impact of compaction on potato yield and quality. Research in Idaho has shown a significant increase in tuber size and percent U.S. No. 1's when conventionally planted potato crops were tilled with an implement designed to break up compaction layers within the row (Soijka et al., 1990). Other production regions have reported losses in marketable yield of 20-30% due to compaction . The most consistent conclusion of all these reports is that soil compaction reduces tuber size and quality to a greater extent than it does total yield. The other important finding is that you cannot overcome compaction by adding additional water, fertilizer, or other amendments to the soil.

## IMPACT OF POST-PLANT TILLAGE ON POTATOES

The optimum period for root growth begins shortly after planting, and continues for a period of about 60 days after emergence, then levels off once tubers start into the rapid bulking phase (Pan et al., 1994). Total root mass generally declines in most varieties

during the later part of the season, as the plant does not replace roots that are lost due to disease or senescence. Many people fail to realize that the root system of a potato plant is fairly extensive at a very early point in the growing season. Tillage operations that occur around the time of emergence can cause extensive root pruning, which will restrict root growth at this critical time, and potentially limit yields in much the same was as compaction does. Research conducted at the Aberdeen R&E Center found a direct relationship between the number of cultivations after hilling and potato yield. Yield declined an average of 4% following each cultivation.

## TREATMENT OF COMPACTED SOILS

Deep ripping and tillage can effectively break up subsurface and surface compaction layers, but is costly and will not completely eliminate the effects of compaction. The best management approach is to focus on prevention, including:

1. Eliminate tillage and traffic on wet soil (most important!)
2. Reduce the amount of tillage
3. Increase organic matter with use of cover crops, forages, crops residues, manure or compost
4. Reduce the number of trips over a field
5. Reduce the area of the field driven upon with controlled traffic
6. Minimize the weight of machinery
7. Improve drainage so soils will dry more quickly

## REFERENCES

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