

Common Soil Constraints

It is important to recognize soil constraints that limit crop productivity, farm sustainability, and environmental quality. Management practices can be adjusted to alleviate these problems. The following is some of the more common soil constraints commonly observed in the U.S., along with some contributing factors and resulting soil conditions.

Soil compaction

Compaction can occur at the surface and subsurface soil profile. Be sure that a soil is ready for equipment prior to tilling.

Contributing factors:

- Traffic or tillage when soil is wet or ‘plastic’ (Fig. 1)
- Heavy equipment and loads
- Uncontrolled traffic patterns

Can result in:

- Reduced root growth in surface and subsurface soils
- Limited water infiltration resulting in runoff, erosion, ponding and poor aeration
- Drought sensitivity due to reduced water storage and rooting
- Reduced nutrient access due to poor root growth and restricted water flow
- Increased pathogen pressure due to poor drainage and plant stress
- Increased cost of tillage; lower yields



FIGURE 1. Tillage when the soil is too wet (plastic) resulting in clodding and compaction.



FIGURE 2. Surface crusting in mid-spring as a result of poor aggregation.

Poor aggregation

Poorly aggregated soils are more susceptible to erosion and runoff which increases risk of lost productivity. Aggregates are formed whenever mineral and organic particles clump together.

Contributing factors:

- Intensive tillage; low active rooting density
- Limited use of soil building crops and soil cover
- Limited duration of root presence during the year
- Limited organic additions
- Low biological activity to stabilize aggregates

Can result in:

- Reduced drought resistance due to crusting and cracking (Fig. 2)
- Poor water infiltration and storage during rain events
- Increased occurrence of erosion and runoff
- Reduced aeration and root growth
- Poor seedling emergence and stand establishment
- Few number of and less active microbial communities

Weed Pressure

When plants are unhealthy and “weak” they are less able to compete against weeds for water and nutrients and defend themselves against pests.

Contributing factors:

- Inadequate crop rotations and omission of cover crops
- Poor weed management; resistance to herbicides
- Poor timing of management practices

Can result in:

- Poor stand establishment and crop growth
- Poor crop quality and reduced yield
- Increased disease and pest damage
- Interference with cultural practices and harvest
- Increased cost of weed control

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High pathogen pressure

Root pathogenesis negatively impacts plant growth and root effectiveness as well as minimizes contributions from microbiota in proper functioning of important soil processes.

Contributing factors:

- Poorly planned crop rotations and low rotational diversity
- Ineffective residue management; poor sanitary practices
- Low microbial diversity, reduced pathogen suppression
- Poor physical soil functioning, particularly waterlogging, or other plant stress-inducing conditions.

Can result in:

- Damaged and diseased roots (Fig. 3); uneven and poor growth
- Reduced yields, crop quality and profit

Salinity and sodicity

Soil problems can be found in arid and semiarid regions, including soils that are high in salts (saline) and those that have excessive sodium (sodic) (Fig. 4).

Contributing factors:

- Frequently found in semi-arid and arid climates, also under irrigated systems or closed, irrigated high tunnels and greenhouses (in the northeast).

Can result in:

- Loss of crop yield and quality
- Loss of aggregation, infiltration and drainage functions

Low water and nutrient retention

Lower organic matter in soils indicates poor structure and lower water holding capacity. Therefore nutrient mobility and plant growth will be limited.

Contributing factors:

- Low organic matter and resulting poor structure, water holding capacity and reduced exchange capacity
- Poor retention and biological recycling of nutrients in biomass and soil organic matter
- Excessive tillage, insufficient use of soil building crops

Can result in:

- Ground and surface water pollution; Reduced microbial community, nutrient deficiencies and poor plant growth



FIGURE 3. Symptoms of root rot diseases on pea roots.

Heavy metal contamination

Contamination from past human activities, such as high traffic, commercial activity, spills, or pesticide application, can negatively impact soil and plant health.

Contributing factors:

- Common in urban areas and other sites with past use of contaminants such as lead paint, fertilizers, pesticides (e.g., lead arsenate use on orchard land)
- Past activities such as high traffic, industrial or commercial activity, treated lumber, machine repair, junk vehicles, furniture refinishing, fires, landfills, or garbage dumps
- Naturally occurring high heavy metal concentrations (generally rare in the Northeast)

Can result in:

- Higher risks of human exposure
- Plant toxicity; inhibition of soil biological activity
- Reduced yield and/or crop quality



FIGURE 4. Saline/sodic soil

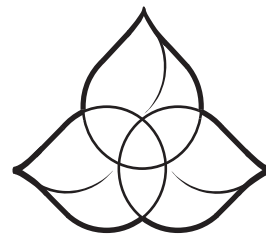
For a more comprehensive overview of soil health concepts including a guide on conducting in-field qualitative and quantitative soil health assessments, please download the Cornell Soil Health Manual at bit.ly/SoilHealthTrainingManual.

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