

Mechanical Impedance of Soil: A Silent Thief

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At present in India, tractors are being used for tillage of 82.78% of total area and sowing 61.30% of total area. Major adoption of agricultural machinery in addition to irrigation equipment and tractor, is thresher. Combine harvesters are commonly used in different parts of the country for harvesting wheat, paddy, maize, soybean and gram in few states. Traditional threshing by animal treading has been almost fully replaced by power threshers operated by 5-15 hp engine or electric motor. Now a day, tractor drawn mould board plough, harrows, cultivators and rotavator are better machinery used by the farmers for cultivation of crops. But continuous use of heavy vehicle induced mechanical impedance in soil and also developed soil compaction.

Mechanical impedance (MI) is an important property of root restricting, tillage-induced pans. It increases with an increase in soil dry bulk density due to soil compaction. Compaction developed due to formation of a plough sole as in the case of rice fields on medium textured soil, use of heavy machinery on a moist soil or presence of kankar (calcium carbonate) layers. Roots growth rate is reduced as mechanical impedance is increased.

Compaction is an apprehension because it affects plant growth. There are not enough pores or spaces in compacted soil to allow unrestricted root movement, infiltration, drainage or air circulation. Restricted roots are often unable to take up sufficient water or nutrients from the soil. Result is less plant growth and lower yields, particularly during periods of drought.

Causes: Soil compaction

Many factors such as animals and machinery causes soil compaction on farms. Machinery is most important factor, mostly tractors and heavy cultivation and harvesting equipments induced soil compaction. The extent of compaction depends on the force compressing the soil, the contact area with the soil, the strength in the soil and the type of soil. Animal

hooves and tyres of light vehicles compact the soil directly underneath and around the contact area. Heavy vehicles compact the soil more deeply.

If we plough regularly to the same depth the soil compacts under the plough and forms a plough pan. Ploughing wet soil causes greater compaction than ploughing dry soil. As well, it may reduce water and air movement. Some soils are more prone to compaction than others, particularly soils with a lot of fine sand and silt and little organic matter. Wet clay is much more easily compacted than dry sandy soil.

Types of soil compaction due to mechanical impedance:

Soil compaction is classified as

1. Surface
2. Subsurface

Surface compaction is usually caused by high contact pressure between the wheel and the soil surface, and is related to the tyre inflation pressure. Freeze-thaw cycles in spring and use of forage crops in a rotation naturally loosen compacted soil. Surface compaction can be reduced by reducing traffic, using lighter machines, using dual wheels and larger tire sizes and reducing tire inflation pressure.

Subsurface compaction often called a plough pan. It is usually more problematic than surface compaction. Since it is not easily detected and is not corrected by natural freeze thaw cycles. It caused both by tillage and by traffic with heavy field machinery. Repeated tillage operations over several years can contribute to both the formation and downward augmentation of a plough pan.

Effect of mechanical impedance on plants and soil

Soil compaction affects plant growth in many ways.

- ✓ Air and water movement and storage in the soil are restricted, causing shortages to the plants.

- ✓ Roots do not develop well or penetrate well in impeded soil, so shallow root systems and malformed roots are symptoms of impeded soil.
- ✓ Plants are generally stunted, and moisture and nutrient stresses may occur.
- ✓ Nitrogen and potassium deficiency symptoms in plants are common under impeded situation. Crop growth and yield probably will be reduced.
- ✓ Impeded soil is more resistant to tillage forces and after tillage tends to be cloddier.
- ✓ Shallowly compacted soil may form a crust after rainfall or irrigation due to poor soil structure and reduced infiltration.
- ✓ Soil compaction affects soil storage and supply of nutrients by increasing soil bulk density, decreasing porosity, soil water infiltration and water holding capacity.
- ✓ Besides increasing runoff and erosion, crusting may impede plant emergence and lead to uneven crop stands.

Preventing measures for mechanical impedance:

- ❖ Mechanical impedance can be best prevented by staying off wet fields. Subsurface drains and contouring promote drainage helping the soil dry out.
- ❖ Tyre inflation pressure may be lowered as these spreads the axle load over a larger surface area. This is especially effective when all field implements have the same working widths (preferably large).

- ❖ Always driving over the same tracks reduces overall field compaction.
- ❖ Deep tillage is often suggested as a method of breaking up plough pans. In this context chisel ploughing is one of the best methods.
- ❖ Deep tillage is likely to be most effective if performed when the soil is very dry in late summer after harvest of a cereal or forage crop.
- ❖ Deep tillage can increase root depth, improve infiltration and water storage and ultimately increase crop yield.
- ❖ To help reduce compaction, it is desirable to conduct normal tillage operations when soil moisture is less than 50 per cent of field capacity.
- ❖ Motivate farmers to cultivate deep rooted crops in the rotation that are able to extend to and penetrate the restrictive layer. This practice should not be applied where unfavourable soil materials such as sodium, calcium, gypsum or other materials.

Soil compaction is fetching a more serious problem for farmers. Because compacted soil has smaller pores and fewer natural channels, water infiltration is drastically reduced. This causes greater surface wetness, more runoff, which in turn increases soil erosion, and longer drying time. This wet field conditions delay planting, harvesting and decrease crop yields. Plant roots do not grow well in dense soil. Restricted moisture and nutrients reach the plant, and consequently yield is reduced. Field machines are heavier so there is motivation for farmers to work the soil when it is too moist is need of the hour.

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