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Effects of Intensive Agriculture on Soil Properties Through Loss of Soil Organic Matter

Introduction

The three components of soil for consideration are physical (texture, structure, aggregates, compaction, water-holding capacity), chemical (cation exchange capacity) and biological (soil organisms) (Dexter, 2004). Soil organic matter (SOM) includes all dead and living organisms within the soil. SOM can be lost due to conventional cultivation techniques (Williams *et al.,* 2005) as well as through the continual removal of plant residues.

Research

Soil quality is hard to define. It is generally considered to be how 'fit for purpose' the soil is. This is dependent on how the soil is being utilised and how fertile/productive the soil is for cropping in an agricultural system. Changes in soil properties can change the ability of the soil to perform its assigned function.

Physical – Aggregate stability is maintained when SOM is continually being replenished as the soil organisms feed on it and break it down. If SOM is not replaced or is depleted, macroaggregate stability decreases, increasing the risk of slaking (Figure 1). This reduces the quantity of macropores and therefore the water infiltration rate.

In a depleted soil a crust may form, sealing the surface. Water will collect and travel on the soil surface increasing the risk of soil erosion as soil particles are carried by the movement of water. Hudson (1994) found that increasing SOM from 0.5% to 3% more than doubled the plant available water in the soil.

Figure 1 - Shows comparison of slake test between soil samples of the same soil type, one of which has not been cultivated for 40 years (l), the other having been cultivated every year for vegetable cropping (r). Clearly the soil on the left is holding together better. (Source: Kloot, 2010)

Decreases in macropores can also lead to compaction as the air spaces are now occupied by the silt and clay components of the slaked aggregates. This leads to a greater bulk density of the soil. The addition of SOM can help reduce bulk density and can help to reduce compaction in the subsoil when faced with high external loads on the topsoil, usually caused by heavy agricultural equipment or high stocking densities (Hamza & Anderson, 2005). Low SOM often exacerbates compaction problems.

Nutrient retention and water holding capacity suffer as a consequence as these would usually be found in the macropore spaces.

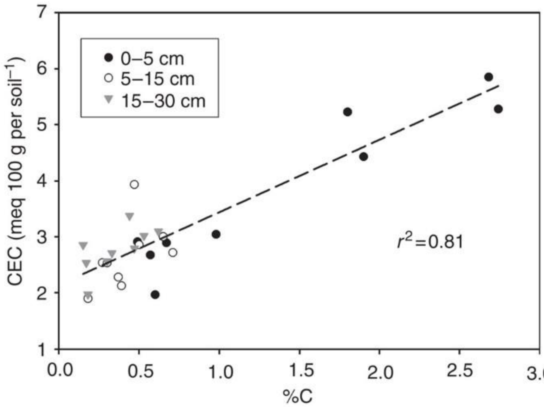

Figure 2 - Shows the relationship between SOM (%C) and the CEC at different depths in the soil profile. (Source: Machmuller *et. al,* 2015)

Chemical – SOM is a significant contributor to soil cation exchange capacity (CEC) as well as nutrient retention abilities. Figure 2 shows how increasing percentage organic carbon (%C) leads to an increase in the CEC of the soil, particularly in top five centimetres. SOM can retain cations (positively charged nutrients), such as Ammonium, due to the negative charges in SOM (Moss et al., 2002).

Biological – In a study conducted by Ponge *et al.* (2013) it was concluded that the 56% decrease in microbial biomass was predominantly explained by the decrease in SOM. The number of soil organisms is vast. Some, such as bacteria, fungi and earthworms, feed on SOM. A reduction, therefore, of SOM means there is less 'food' for those organisms to survive. Earthworms are vital in homogenising SOM with the rest of the soil profile making vital nutrients available for use by plants.

Conclusion

SOM is critical in maintaining a balanced soil ecosystem. With increasing demands on agricultural productivity and the intensification of agriculture, SOM is clearly going to have a substantial role in improving soil quality and increasing the soil's ability to be productive and fertile. Other environmental benefits such as reduced nutrient leaching and soil erosion will also be achieved.

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