Biosolids application to salt affected soils: its effects on soil organic matter, microbial biomass and sodicity

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Abstract

Extensive areas in arid and semi arid regions around the world are salt affected. Both soil salinity and sodicity directly and indirectly affect plant growth and survival. With their characteristic low organic matter contents, sodic soils have encouraged researchers around the world to investigate possible alternative organic ameliorants which could increase soil organic matter and hence improve soil structural properties to an extent that can lead to desodification. As a result, organic matter ameliorants ranging from cottage cheese whey to green manure or pig bedding litter have been explored some with greater success than others. This study investigates the possibility of dry and wet biosolids as ameliorants improving the soil organic matter contents and its influence in reducing sodicity.

Key Words

Sodicity, organic matter, structural properties, organic ameliorants, biosolids.

Introduction

Victoria's Western Treatment Plant (WTP) at Werribee has a history of raw sewage land application supporting primary production in growing pasture that dates back to the 1890s. As a result, although being salt affected, these soils have a relatively high organic matter (OM) content (unpublished data shows these soils have an ESP in the range of 10-39 while having % OC in the range of 2.5-6.5). It is believed that sodic soils high in OM content, albeit not all types of OM, can resist dispersion well (Figure 1).

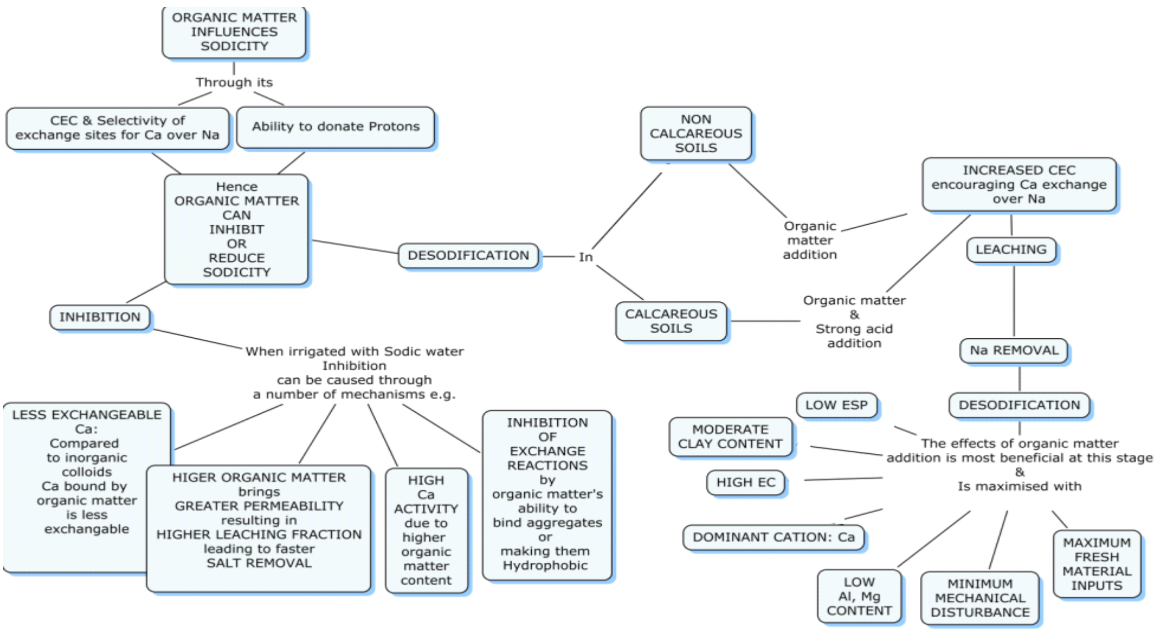

Figure 1. Influence of organic matter on sodic soil reclamation.

Since land application of raw sewage stopped in 2004, some paddocks have been dried off which neither received any irrigation nor supported any grazing. Soil samples from one such paddock were collected and soil organic matter tests carried out in late 2005 for a Masters Project. The same sites were sampled again in 2008 for this study and have shown significant reductions in %OC as shown in Figure 2.

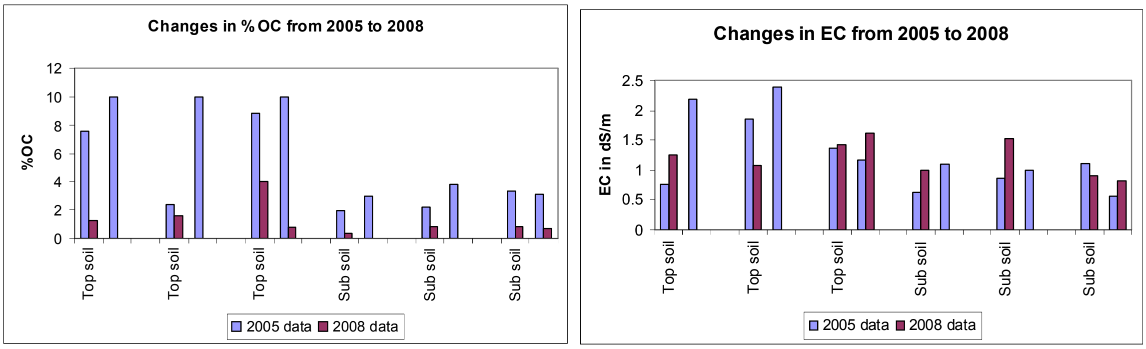

Figure 2. Changes in %OC and EC at WTP from 2005 to 2008.

Whether this reduction is significant enough to cause structural deterioration, and if they were, whether organic matter ameliorants similar to the ones these soils have previously received would be a good choice for these soils are currently being investigated. This paper only highlights the effectiveness of increasing soil OM content and Total Microbial Biomass (TMB) and their influence on sodicity. A popular approach established in the 1980's and 90's to improve soil structure in salt affected arid and semi arid regions where soil OM is low, was the incorporation of organic residues through the direct land application of either wastewater or solid and semi solid waste products (Tisdall and Oades 1982); (Angers and Carter 1996); (Haynes and Swift 1990). As shown in figure 2, the OM of the WTP soils reduces quickly if the source is removed and hence how they would respond to any organic ameliorants is worth investigating.

Soil Samples

Samples were collected in February 2008 from WTP from a paddock no longer receiving wastewater irrigation. Top soil samples were collected from the 0-100mm depth and sub soil samples were collected from the 100-300mm depth.

Sample preparation

Composite samples collected from the site were mixed uniformly using a cement mixer then potted in 16 cm diameter, 18 cm high plastic pots with openings at the bottom to facilitate drainage. Both dry (dried for 5 months on a sludge drying bed) and wet biosolids (dried for 5 weeks on a sludge drying bed) were collected from the site and blended as follows:

Profile position	Topsoil (T)		Subsoil (S)		
Water Quality	Potable Tap (D)	Tertiary Treated Sewage (R)			Raw Sewage (W)
Biolsolids mass (g/kg)-ratio dry to wet	150-100:0	150-80:20	150-60:40	50-100:0	0

Treatments were labeled with the letter in brackets following the treatment name and with the mass and ration of biosolids added. Raw Sewage was only applied to soil without biosolids added.

Irrigation Water

Each week for 24 weeks, the pots were irrigated with 100ml of Tap water, untreated Waste water or Tertiary treated Recycled water.

Table 1: Water Quality parameters (Source: measured and personal comm. with Melbourne Water)

	pH	EC (µS/cm)	BOD_5 mg/L	TSS mg/L
Tap water	7	137.6	0	0
Recycled water	8.4	1900	<10	< 5
Wastewater	7.9	2200	590	490

Methods

(1) Total Organic Carbon (Walkley-Black method) (2) Scanning Electron Microscopy (Quanta ESEM) (3) Exchangeable cations (Na, K, Ca, Mg, Al) were measured by CSBP soil and Plant Laboratory in Western Australia for ESP and Cation Exchange Capacity (CEC) measurements as well as (3) TMB.

Results

Organic amendments used to reclaim salt affected soils have been shown to improve soil stability, through enhanced soil microbial activity which transforms the newly added organic matter into materials like polysaccharides and long chain aliphatic compounds which help to bind and stabilize aggregates (Perucci 1990); (Plante and Voroney 1998). This is of course true only when the added organic matter is well decomposed and has blended properly with the aggregates. As figure 3 shows, most of the biosolids applied, did not blend well with the aggregates giving hotspots of non decomposed OM.

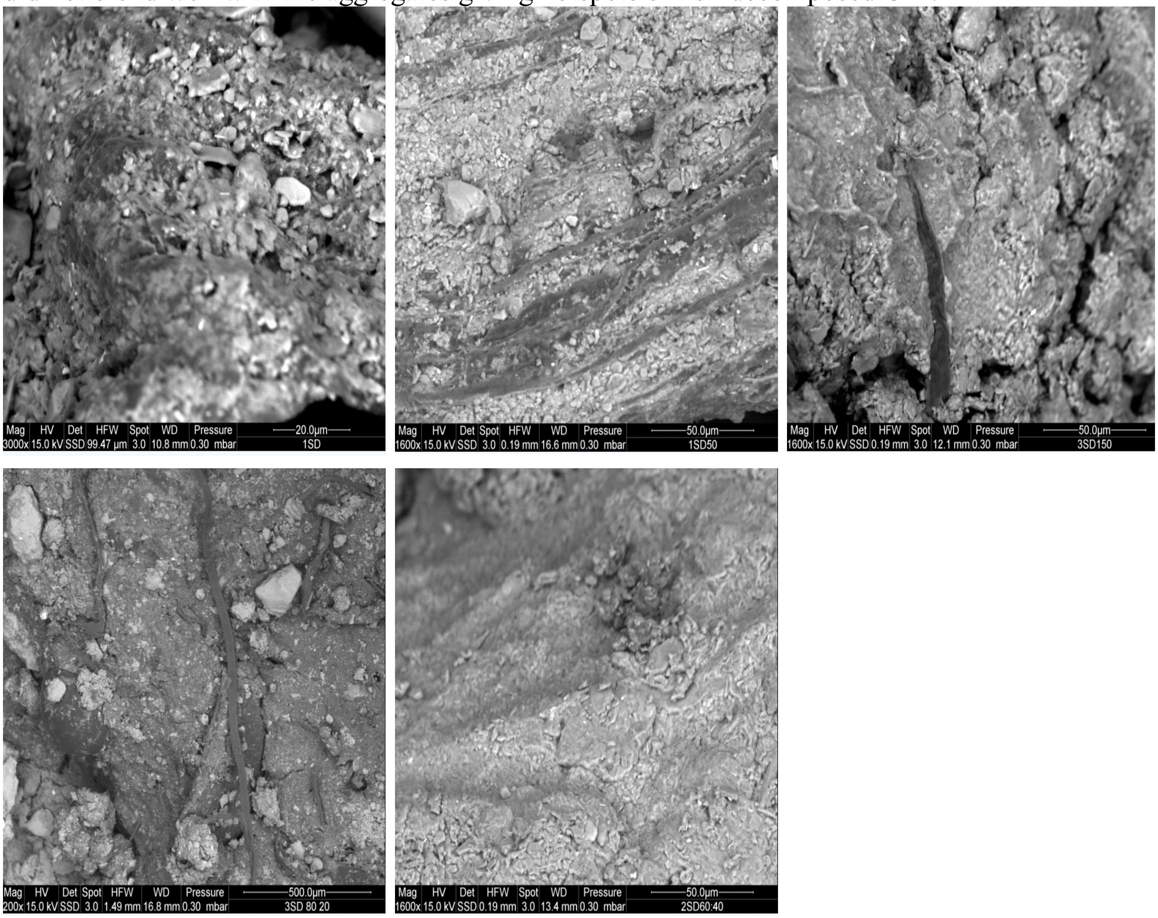

Figure 3. SEM images of sub-soil samples irrigated with tap water mixed with different proportion of biosolids amendments.

The most efficient use of added OM is probably the [the image in the bottom right] where the OM seems to have blended well to form a web over the moist aggregates. Microorganisms also promote aggregation through fungal filaments (Tisdall & Oades 1982) , or bacterial gums and exudates(Graber *et al.* 2006). From the figure 4 apart from a few exceptions (e.g. TR 80 20, TR 60 40 & SD 60 40) TMB has been seen to increase with biosolids amendment which increased CEC and decreased ESP. Dry biosolids proved to be more effective in increasing soil OM (exception: SR 60:40), CEC and TMB while reducing ESP. When the dry biosolids are blended @ 80:20 with the wet biosolids, it gives in most cases very similar results to the 150g/kg blend, but when it is blended @ 60:40 there is a marked change.

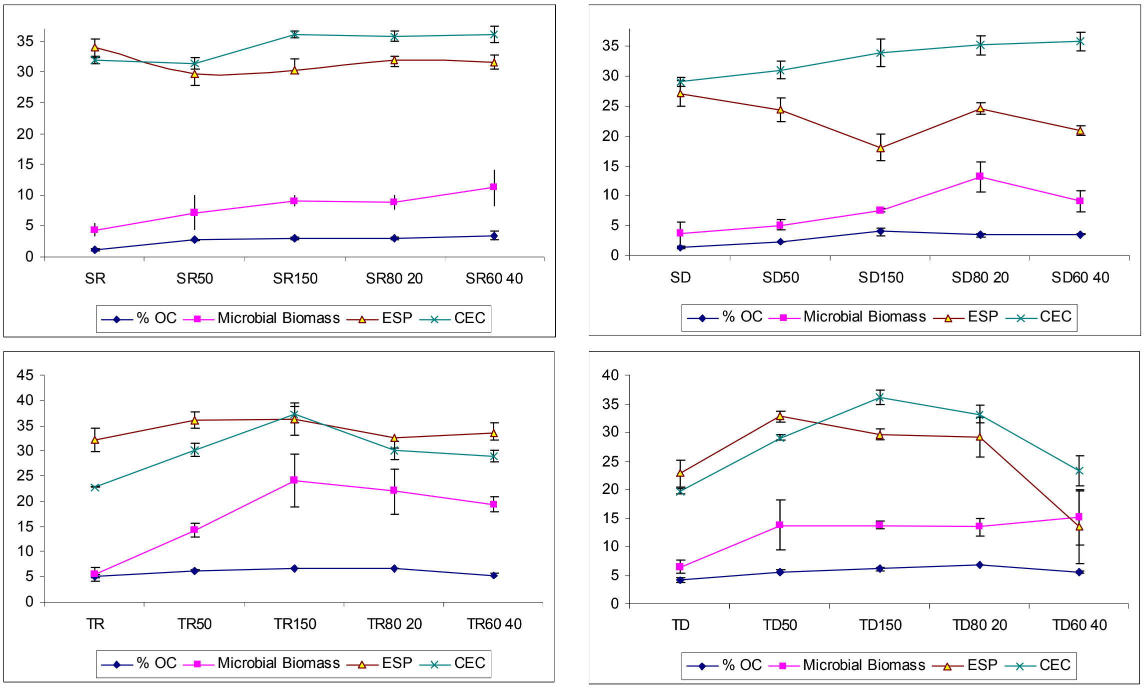

Figure 1. Changes in % OC, TMB, ESP and CEC brought about different proportion of biosolids amendments and irrigation water qualities.

Conclusion

Dry biosolids was found to be more effective in increasing the % OC, TMB and CEC while decreasing ESP (evident in the soil samples having 150g dry biosolids/kg soil) compared to the wet. The impact of these changes on the structure of these soils is still under investigation.

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