

Information Sheet No. 6-2

Benefits of organic matter in soil

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Introduction

Organic matter helps bind soil particles together, provides nutrients to plants and other soil organisms, and protects soil from physical or chemical degradation.

Due to their age and climatic conditions, the majority of Australian soils have very low levels of organic matter, ranging from <1% in dry inland areas to extreme highs of 50% in cold, alpine, well-watered regions (Charman and Roper, 1991). On average, however, organic matter levels in cropping soils range from 1.6 to 4.6% (Hamblin, 1980).

This deficiency in soil organic matter contributes to poor soil physical and chemical fertility and related land degradation problems. The addition of materials high in organic matter (e.g. products containing *recycled organics*) helps improve poor and degraded soils in a number of ways.

Products containing recycled organics (RO) include:

- Potting mixes
- *Mulches*
- *Soil conditioners*

- Organic soils (topsoil)
- Blended soils (topsoil)
- Top dressing
- Low density soils

The products identified in this Information Sheet are consistent with the specifications given in the various Australian Standards (see Information Sheet 6-5).

Each of these products offers a range of benefits to soil and landscapes. RO products are manufactured for a range of applications and different scales of application, such as:

- Potted plants
- Home gardens
- Commercial landscaping
- New housing developments
- Parks, gardens, playgrounds and other community open spaces
- Roadside applications
- Forestry and agricultural applications
- Mine site applications

Benefits of organic matter to soil

Increased organic matter levels in soils and on the soil surfaces

Plate 1. Composted soil conditioner added to a soil bed at The University of New South Wales.



contribute to:

- Improved soil physical, chemical and biological properties;
- Improved plant growth, and
- Reduced maintenance and management requirements.

These benefits are described in greater detail below.

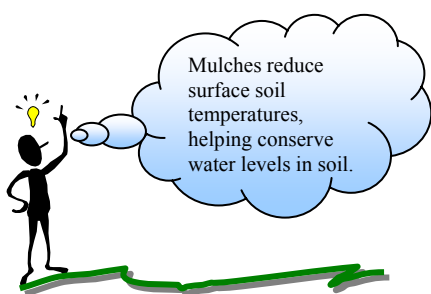
A. Soil physical properties

Soil physical properties take into account the *structure* of a soil, its stability, and the soil's capacity to recover from disturbances (e.g. tillage).

These soil attributes are intimately related to the chemical and biological properties of a soil, past and present management practices, and climatic conditions.

The majority of research (e.g. Dubey and Mondal, 1993; Eltilib *et al.*, 1995; Valzano *et al.*, 1997; and Wahid *et al.*, 1998) indicates that increased levels of organic matter have beneficial effects on soil stability.

The presence of organic matter on soil surfaces or within soil profiles has many benefits, as follows:



i. Surface protection

The addition of mulch (and hence organic matter) to soil surfaces, directly protects soil from wind and water erosion (Valzano, 2000), while enhancing water penetration, soil moisture contents, and reducing soil temperatures.

ii. Raindrop impact

Mulch protects soil surfaces from *raindrop impact* related *crust* formations (Charman and Roper, 1991; Albaladego *et al.*, 2000; and Gibson, 2000). Soil crusts may hinder the movement of water into soil, increasing the potential for water flow on soil surfaces and related erosion. In addition, reductions in surface infiltration result in reduced soil water contents.

iii. Wind and water erosion

Wind and water related processes can strip away unprotected fertile soil surfaces, reducing soil quality and increasing erosion by exposing less fertile and unstable subsoils to the elements.

Brown *et al.* (1998) found that the use of organic mulch dramatically reduced the amount of erosion in irrigation furrows and improved water infiltration rates by 50-60 %.

iv. Water penetration

The presence of a surface mulch facilitates better water penetration into soil. This increase is related to improved soil structure and stability and increased biological activity.

Increased water penetration helps reduce surface evaporation and runoff of water, as the soil surface is protected from direct sunlight and from the mechanical impacts of rainfall and irrigation (Charman and Roper, 1991).

v. Soil moisture retention

Mulch at the soil surface helps maintain/increase moisture levels in the soil by reducing evaporation at the soil surface (Huang and Shen, 1999; Gibson, 2000). Improved moisture levels may assist with plant growth in situations where water is limited (Stirzaker and Bunn, 1996).

Definitions*

Recycled organics

The term Recycled Organics has been adopted by NSW Waste Boards as a generic term for a range of products manufactured from compostable organic materials (garden organics, food organics, residual wood and timber, biosolids and agricultural organics).

Mulch

Any pasteurised organic product (excluding polymers which do not degrade such as plastics, rubber and coatings) that is suitable for placing on soil surfaces. Mulch has at least 70% by mass of its particles with a maximum size of greater than 15 mm.

Soil conditioner

Any composted or pasteurised organic material that is suitable for adding to soils. This term also includes 'soil amendment', 'soil additive', 'soil improver' and similar terms, but excludes polymers which do not biodegrade, such as plastics, rubber and coatings. Soil conditioners may be either 'composted soil conditioners' or 'pasteurised soil conditioners'. Soil conditioner has not more than 15% by mass of particles with a maximum size above 15 mm.

Soil structure

Soil structure is described as the arrangement of sand, silt, clay and/or organic matter into units called aggregates (Charman and Murphy, 1991).

Raindrop impact

A mechanical process by which droplets of rain hit exposed soil surfaces and cause the detachment and dispersion of soil particles. This process leads to the formation of a crust at the soil surface, impeding the movement of water into the soil (Charman and Murphy, 1991).

Crust

A thin continuous layer of clay sized particles at a soil surface, which impedes the movement of water into soil (Charman and Murphy, 1991).

*Recycled Organics Unit (2000)

Gao *et al.* (1999) found that the application of organic mulch in wheat fields to be the best way of conserving soil moisture. Wheat yields were increased by more than 20% in mulched paddocks.

Buckerfield and Webster (1995) showed that the surface application of organic mulches to vineyard soils resulted in a 34% increase in soil moisture content and an increase in grape yields.

Improved water contents enhance soil biological activity, which can improve soil physical and chemical properties, resulting in better plant growth.

vi. *Soil temperature*

Buckerfield (1998) found that the addition of a surface mulch led to a reduction in Summer soil temperatures (up to 2°C) in a number of horticultural crops. Lower temperatures contributed to less evaporation and increased soil moisture levels during this period. These temperature improvements helped reduce plant stress and improved biological activity in soil.

vii. *Soil density and porosity*

The presence of organic matter assists in the formation of *soil aggregates*. These contribute to a more porous and less dense soil (Brandsma *et al.*, 1999). Soil porosity and density impact upon plant growth and the capacity of soil to resist degrading processes.



The presence of mulch on soil surfaces improves soil biological activity and porosity

Brandsma *et al.* (1999) showed that the use of soil conditioners (organic and inorganic varieties) reduced soil density and increased porosity. Similarly, Barzegar *et al.*, (1994) showed that soils with higher organic matter contents were more stable and less dense than equivalent soils with less organic matter.

viii. *Aggregate stability*

Soil *aggregate stability* is important for the development and maintenance of a well structured soil. Reductions in aggregate stability may lead to an overall decrease in soil physical and chemical fertility. As organic matter content and biological activity increase, soil aggregates become much more stable, making them resistant to breakdown when exposed to wind, water or mechanical stress (e.g. tillage).

Work by Dubey and Mondal (1993), Etilib *et al.* (1995), and Wahid *et al.* (1998) indicated that the addition of large quantities of organic matter (up to 3% of total surface soil weight) helped improve soil stability and *available water holding capacity*.

B. Soil chemical properties

Organic matter from soil conditioners, and to a lesser extent mulches, directly contributes to soil nutrient levels.

The physical and biological decomposition of organic matter in soil assists with the release and retention of plant accessible nutrients. These nutrients aid in the growth and productivity of plants (Charman and Roper, 1991).

Lehrsh *et al.*, (1994) also found that the addition of an organic soil conditioner to a sodium affected soil reduced the proportion of sodium in the soil and increased aggregate stability, making the soil less susceptible to compaction —

Definitions (cont.)

Soil aggregates

Aggregates are units of particles formed from combinations of sand, silt, clay and/or organic matter (Charman and Murphy, 1991).

Aggregate stability

Describes the size range and stability of soil particles that have been wetted and exposed to some form of disturbance (Charman and Murphy, 1991).

Available water holding capacity

The amount of plant accessible water present in a soil (Charman and Murphy, 1991).

*Recycled Organics Unit (2000)

contributing to improved plant growth.

C. Soil biological properties

Increased levels of organic matter at soil surfaces and within soils can enhance soil biological activity (e.g. earthworms and microorganisms) (Valzano *et al.*, 2000).

Fungal threads and the secretion of organic gums by microorganisms helps bind mineral soil particles together. This leads to better soil structure (Handreck and Black, 1999).

Increased biological activity can benefit soil structure and chemical composition. These biological improvements influence:

Water penetration at the soil surface

Increased soil faunal activity can contribute to the formation of channels at the soil surface and also within a soil. These channels improve water infiltration and drainage, reducing soil susceptibility to water logging.

Porosity and continuity of pores within the soil

Mulch and soil conditioner related improvements in soil environments give rise to increased earthworm and ant activity. These animals directly add to the porosity of the soil, as they form interconnected networks of channels in soil (Valzano, 2000). This assists in better plant growth by making it easier for plant roots to penetrate soil.

Water and nutrient availability to plants

Soil structural improvements can contribute to an increase in water and nutrient accessibility to plants. Valzano (2000) showed that water availability was on average 10% higher in agricultural soils with a surface mulch than in equivalent exposed soils. Such effects on soils are also applicable in urban situations (e.g. parks and gardens).

D. Reduced maintenance and management requirements

In addition to directly benefiting soil organic matter levels, the use of RO products reduces the level of maintenance required for a garden, park, paddock etc.

Reduced watering or irrigation requirements

Improved water infiltration and storage in soil reduces the frequency and volume of watering or irrigation required to:

- Maintain plant health and vigour;
- Increase plant establishment, and
- Reduce seedling losses.

Weed suppression

The use of surface mulches suppresses weeds in gardens and paddocks (Haywood, 1999; Jackson, 2000), reducing time required for weed control.

Haywood (1999) found that mulching killed weeds and seeds. In addition, unwanted vegetation did not readily reestablish following the decomposition of the mulch, giving better growing conditions for seedlings.

Disease suppression

The application of surface mulches may help alleviate the effects of soil pathogens such as *Phytophthora nicotianae* on the growth of plants. For example, Widmer *et al.* (1999) found that the application of composted mulch to orchard soils infested with *P. nicotianae* resulted in an increase in the rate of growth of tangerine trees regardless of the level of pathogen infestation.

Gibson (2000) showed that apple seedling survival was increased by over 50% following the application of a composted soil conditioner. Tree growth was also promoted by soil conditioner and mulch applications.

Composted RO products contain very large populations of beneficial bacteria, fungi and actinomycetes. When applied to soils these microorganisms compete with plant pathogens, causing a decline in plant pathogen numbers and less plant disease (Hoitink and Fahy, 1986).

Mulches and soil conditioners can also indirectly reduce pathogen effects by increasing drainage and reducing plant stress.

Reduced use of inorganic ameliorants and fertilisers

The use of RO can help stabilise soil physical properties, reducing the need for such inorganic amendments as lime or gypsum.

As mulches or soil conditioners may add to soil nutrient content and retention, the need for inorganic fertilisers is often reduced.

Conclusions

The use of RO products directly impacts upon organic matter levels in and on soils.

Increased organic matter levels produce improvements in soil physical, chemical and biological fertility.

Improved soil properties help create a more sustainable environment in which plants can be established and grow more efficiently and land degradation forces are negated, so that these improved growing conditions are maintained.

Maintenance and management requirements can also be reduced in situations where RO products are applied to soil.

In general, RO products improve soil health, and improve the establishment, survival and vigour of plants.

References (cont.)

- Charman, P.E.V. and Roper, M.M. (1991). Soil organic matter. In: P.E.V. Charman and B.W. Murphy (Eds.), *Soils: Their Properties and Management*, pp 206-214, Sydney University Press, Sydney.
- Charman, P.E.V. and Murphy, B.W. (1991). *Soils: Their Properties and Management*. Sydney University Press, Sydney.
- Dubey, S.K. and Mondal, R.C. (1993). Sodic soil reclamation with saline water in conjunction with organic and inorganic amendments. *Arid Soil Research and Rehabilitation*. **7**, 219-231.
- Eltilib, A.M.A., Elamahi, Y.E., Magid, H.M.A., and Ahmed, B.A.M. (1995). Response of wheat to irrigation frequency and manuring in a salt affected semi-arid environment. *Journal of Arid Environments*. **31**, 115-125.
- Gao, Z., Yin, J., Miao, G., and Gao, F. (1999). Effects of tillage and mulch methods on soil moisture in wheat fields of Loess Plateau, China. *Pedosphere*. **9**, 161-168.
- Gibson, T. (2000). Recycled Organics in Agriculture – Benefit or Risk: Research in agriculture. Central Coast Waste Board. pp 1-13. Hamblin, A.P. (1980). Changes in aggregate stability and associated organic matter content properties after direct drilling and ploughing on some Australian soils. *Australian Journal of Soil Research*. **28**, 11-23.
- Huag, J.S., and Shen, R.K. (1999). Analysis of crop evapotranspiration under transparent polyethylene mulch. Irrigation under conditions of water scarcity. Vol 1A ICID International Congress on Irrigation and Drainage, Granada Spain, 13-17 September 1999. New Delhi: International Commission on Irrigation and Drainage, 1999. 327-338.
- Handreck, K.A. and Black, N.D. (1999). *Growing Media for ornamental plants and turf*. University of New South Wales Press, Sydney, Australia.
- Haywood, J.D. (1999). Durability of selected mulches, their ability to control weeds, and influence growth of loblolly pine seedlings. *New Forests*. **18**, 263-276.
- Hoitink, H.A.J., and P.C. Fahy (1986). Basis for the control of soilborne plant pathogens with composts. *Annual Review of Phytopathology*. **24**, 93-114.
- Jackson, M.J., Line, M.A., Wilson, S. and Hetherington, S.J. (2000). Application of composted pulp and paper mill sludge to a young pine plantation. *Journal of Environmental Quality*. **29**, 407-414.
- Lehrsh, G.A., Robbins, C.W., and Hansen, C.L. (1994). Cottage cheese (acid) whey effects on sodic soil aggregate stability. *Arid Soil Research and Rehabilitation*. **8**, 19-31.
- Recycled Organics Unit (2002). *Recycled Organics Industry Dictionary & Thesaurus: standard terminology for the recycled organics industry*. Recycled Organics Unit, internet publication: <http://www.rolibrary.com>
- Stirzaker, R.J., and Bunn, D.G. (1996). Phytotoxicity of ryegrass and clover crops, and a lucerne alley crop for no-till vegetable production. *Biological Agriculture and Horticulture*. **13**, 83-101.
- Valzano, F.P., Greene, R.S.B. and Murphy, B.W. (1997). Direct effects of stubble burning on soil hydraulic and physical properties in a direct drill tillage system. *Soil and Tillage Research*. **42**, 209-219.
- Valzano, F.P. (2000). The effects of chemical ameliorants, tillage and stubble practices on sodic soils in Australia. PhD Thesis. The Australian National University.
- Valzano, F.P., Greene, R.S.B., Murphy, B.W., Rengasamy, P. and Jarwal, S. (2000). The long term effects of gypsum and stubble management on a grey vertosol. National Sodicy Conference. Tatura, Victoria, 28 February - 1 March 2000.
- Wahid, A., Akhtar, S., Ali, I., and Rasul, E. (1998). Amelioration of saline-sodic soils with organic matter and their use for wheat growth. *Communications in Soil Science and Plant Analysis*. **29**, 2307-2318.
- Widmer, T.L., Graham, J.H., and Mitchell, D.J. (1999). Composted municipal solid wastes promote growth of young citrus trees infested with *Phytophthora nicotinanae*. *Compost Science and Utilisation*. **7**, 6-16.

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