Alternative Fertilisers and Soil Amendments

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Introduction

A wide range of products are now available which are considered alternative fertilisers or products which can be used to enhance soil fertility, structure or biological health. This fact sheet summarises many of these and our current level of knowledge. It must be recognised that many alternative fertiliser are yet to be field tested and our knowledge is still improving on them. Also, many products sold are now mixtures of several of these products.

When considering a new alternative product for your soil some key considerations need to be made.

1. What soil limitations occur in your paddock? Have you done a recent soil test and what inherent issues occur with this soil type?
2. Have you information on the ingredients of the product and what the nutrient and organic matter content is?
3. Has there been any local independent testing of the products and results produced etc?

If unsure about the above ensure you use these products with caution and ensure you have nil strips or encourage local testing. In the ideal world replicated trials should be undertaken to prove new products, however this is difficult to achieve with the numbers of products always becoming available. Price comparison (for example the relative cost per nutrient) need to be made on various options. Historically, these products have been used for surface soils but there is increasing interest in subsoil applications.

Products can be grouped into several types

1. Organic Material Suppliers including composts, coal dust, biochar, peat
2. Nutrient Rich Waste products including manures, biosolids
3. New and modified fertiliser forms including Liquid P/ Phosphoric acid, slow release fertilisers
4. Natural mineral additives including gypsum, lime/ dolomite, local clay, bentonite, rock phosphate
5. Soil Biological/ bacterial mixes

A summary of products is included below, note that this is not a complete list and there may be other products in the market place not reviewed that has no reflection on the quality of these products.

Composts

Mt. Gambier produces composted organic matter (OM) from pine and other local waste. Its characteristics include 80-90% OM and neutral pH. Composts are generally more active than coal and with some sources no additional nitrogen (N) is recommended– can blend with peat etc. Mt. Gambier products have been widely used as mulch for vines or for nurseries/ potting mix. They meet Australian Standards including pasteurising. Other composts are available through the viticultural areas including Padthaway.

Coal Dusts

Coals dust and derivatives have been used to try and improve the cation exchange or organic component of the soil. Generally, the poorer the quality as a coal, the better as a soil additive.

Coals are characterised by high organic matter, high Cation Exchange Capacity (CEC) (>250 in some cases), have a higher conversion to soil organic carbon (OC) than other sources of organic matter as less reactive, very fine, less reactive organic matter source, but expensive due to transport.

Biochar

There is a lot interest in biochars through possible greenhouse gas reduction where waste organic material is converted to biochar (stable organic matter) by pyrolysis. Syngas is produced in the process as a by-product. Current research is demonstrating there is a large variation in biochar depending on source and the oven. Yield responses have been variable with better responses on sandy soils and no response on black clays.

Table 1. Types of soil organic carbon

Organic carbon pool	Size	Stability	Turnover time	Key functions
(1) Crop residues Shoot and root residues on and in the soil. Soil biota decomposition.	> 2mm	(readily available)	Days	Provide energy and nutrients to biological processes; readily broken down providing soil conditions that favour soil biology
(2) Particulate organic matter (POM) Smaller plant debris	0.05-2mm			These are broken down relatively quickly in suitable conditions but more slowly than crop residues. Important for soil structure, provision of energy for biological processes and nutrients.
(3) Humus Decomposed material dominated by molecules stuck to soil minerals	< 0.05mm		Decades	This plays a role in all key soil functions, but is particularly important in the retention and provision of nutrients (e.g. the majority of available N is found in the humus fraction).
(4) Recalcitrant organic matter Biologically stable, dominated by pieces of charcoal	variable	Very stable / relatively inert	Hundreds of years	Decomposes very slowly and if present in large enough quantities can contribute to increased cation exchange capacity as well as controlling soil temperature.

Peat

Local peats formed in lacustrine sediments are possible sources of organic matter in the South East and are mined and sold in various places. In an analysis from a bulk pit at Millicent (Bailey, 2004) peat had Organic Carbon 43% (up to 60% on soil pit), pH 7.3, CEC 130-140 with significant levels of calcium, iron, sulphur.

Note, can vary significantly in terms of pH and organic matter.

Table 2. Comparison of Some Organic Matter and Clay Sources

Product	CEC	Organic Matter %	pH	Variable
Coal Dust	250	90-100		
Compost		80-90	7.0-7.5	
Peat	130-140	60-90	7.3	pH variable
Biochar	150-300	High	Normally alkaline	
Bentonite	53-86	Nil	5-10.4	variable
Local Clay	12-21	Nil	7-10	

Increasing organic matter in soils – how much do you need?

A soil with an organic carbon content of 1% contains 14t/ha of organic carbon (OC) or about 20t/ha of organic matter (OM) in its surface (0-10cms).

Therefore, adding small amounts will have little effect on this. In the Tarlee rotation trial in the mid North it took 10 years to be able to measure the differences in OC between burnt and non-burnt stubble.

The more active organic amendments will increase OC at an effectiveness of 10-20%. Therefore, at a rate of 10t/ha will increase OM by 1-2 t/ha or around 0.1%.

Less active products such as coal dust or biochar will have a much higher efficiency and rate of conversion to OM.

For humus to accumulate and increase enough N, phosphorus (P), potassium (K) and sulphur (S) must also be present, and if the other nutrients are not present organic matter maybe volatise rather than build up.

Manures

Chicken and pig manures and wastes are already widely used by various farmers and as base products for organic fertilisers. Recent evaluation (refer to Rural Directions) showed chicken manure to be cost comparative to conventional fertilisers where freight costs are not high. While nutrient contents can be comparable, manures will break down much slower than conventional fertiliser so some supplementation may still be required particularly in deficient soils. Manure availability from chicken sheds and dairies are on the increase.

Sources will vary enormously between producers but can get a basic analysis done for $50-70 per sample.

Table 3. Ball park nutrient content (%) at 50% moisture, double figures for dry weight

Source	Nitrogen	Phosphorus	Potassium	Organic Matter
Chicken	0.8-2.6	0.6-2.0	0.4-1.2	30-35
Pig	0.6-1.2	0.5-0.8	0.4-1.0	15-20
Sheep	0.5-1.4	0.4-1.0	0.5-0.7	30-35
Cow	0.8-1.1	0.5-0.8	0.4-1.3	15-20
Bolivar Biosolids	1.2	1.2		4.2

Table 4: Nutrient Value per kilogram in chicken litter example based on prices per kg of nutrient in mineral fertilisers (from Rural Directions)

Nutrient	Nutrient Concentration (dry weight basis)	Moisture content of Litter	Nutrient Concentration (% fresh wt)	Nutrient applied per tonne (fresh wt)	Nutrient applied in 2.5 tonnes per ha	Nutrient Value per 2.5 tonnes
Phosphorus	1.2%	20%	1.0%	10kg	25kg	$100
Nitrogen	3.5%	20%	2.8%	28kg	70kg	Not valued1
Potassium	2.0%	20%	1.6%	16kg	40kg	Not valued2
Zinc	400mg/kg	20%	320mg/kg	300g	750g	$3.33

Biosolids

Biosolids are produced from various waste streams including sewerage sludge. Bolivar produces around 40,000 tonnes per year from the bottom of the sewerage ponds. Bolivar product is free although landholders must pay for freight and spreading and adhere to various guidelines. Depending on freight and cost Bolivar biosolids were also shown in the Rural Directions study to be cost comparative. Bolivar product at 5t/ha has good levels of P, N, S, calcium (Ca), zinc (Zn), copper (Cu) but also contains some heavy metals. More sources of biosolids are likely to become available in the near future.

Liquid P/ Phosphoric Acid

Generally, liquid P is considered more effective than conventional fertilisers on highly calcareous soils but considerably more expensive (generally up to twice as effective but 3-5 time more expensive). On non calcareous soils results have been mixed with some advantages in some years but not consistent (several years of work on Eyre Peninsula).

Slow Release fertiliser

There have been several products tried such as wax coated products like Osmocote. They often have good results in wet leaching years but there is a question over the economics of most of these products in broad acre agriculture. They are also used in some cases to reduce toxicity of urea at seeding. They may have more benefits for consideration under carbon farming proposals to reduce nitrous oxide emissions from waterlogged soils.

Gypsum

Calcium sulphate with some level of impurity is available from Cookes Plain, Meningie and other sources in South East. It is generally used as cheap source of sulphur, calcium or for improving sodic/dispersive soils. New liquid forms are becoming available in suspension. There were large responses in 1990's work to trenching gypsum into sodic clays at Bordertown. It is reasonably soluble – 100mm rain will dissolve 1 t/ha and it will become pH neutral over time.

Lime/Dolomite

Calcium carbonate (lime) and calcium/ magnesium carbonate (dolomite) can be used mainly to correct acid soils or slow release forms of calcium/ magnesium – sometimes applied to composts etc to correct pH – many sources in the South East. Lime is up to 100 times less soluble than gypsum. In the South East irrigation water can often supply lime.

Local Clays- widely used on WRS Sand

Generally analysis suggests around 20-50 % clay. Its features include: variable pH from neutral to alkaline (take care if acid), low levels of organic matter, significant calcium, magnesium and potassium, significant variation down pits, less variation when using delving although still some, and cheap and available to apply when existing within the paddock. There is reasonable research knowledge on issues and success. Demonstrated benefits include reduced water repellence, improved nutrient and carbon holding capacity, reduced frost damage, increased pH and improvement to A2 and top of the clay when delving.

Bentonite

Bentonite is an extreme swelling clay used for various tasks including lining dams and sealing piezometers. It has been considered as a product which could be added to sandy soils and may assist in holding subsoil nutrients.

In summary trials on sandy soils on Yorke Peninsula, application of bentonite showed significant reduction in water repellence with 1 to 10 t/ha, however, no yield increase was demonstrated. It has a high CEC, variable pH depending on source and is highly dispersive. However, it is costly to transport.

Rock phosphate

Reactive phosphate rock (RPR) was comprehensively tested throughout Australia in a national program during the 1990s. Key outcomes of this program were for SA that RPR is considered of limited value and less effective than other products. It was considered most suitable to acid sandy soils in high rainfall areas which had good levels of fertility and phosphorus. Issues encountered under this program included sulphur issues, slow breakdown on responsive sites and need to lime acid soils.

Soil Biological/bacterial mixes

Changing soil organic matter, pH, fertility and cultivation practice result in significant changes to soil microbiology. Several products are available which may support microbial activity by adding beneficial organisms to the soil. Success has been had with adding rhizobia to legumes to improve symbiotic nitrogen fixation. Other products have had poor and inconsistent results possibly due to adding a very small sample of biota to an extremely large pool of existing microbes. Testing for microbial biomass and broad types can be undertaken. New DNA testing will allow greater understanding.

Humic Acid

This is the principal component of humic substances including humus, peat and coal, produced from degradation of organic matter. Fulvic acids are humic acids of lower molecular weight and with higher oxygen content. There are extremely variable reports on the effectiveness of these products as soil improvers or on impacting on yields.

References/ Further Reading

Rural Directions- Chicken Litter as a Fertiliser for Grain Crops. A Users Guide. RIRDC – see Rural Directions web site.

Biosolids guide- from United Water.

Reactive Phosphate Rock (RPR) Findings from the National RPR Research Program 91-96.

www.soilquality.org.au

If you are interested in finding out more please contact Natural Resources South East, Land Management Adviser by phone on 08 8735 1177 or dewnr.naturalresourcesse@sa.gov.au or visit www.naturalresources.sa.gov.au/southeast