

Composting in Australian cotton production

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There has long been an interest in the use of composts within the Australian cotton production system. This has been reinforced by recent investigations into cotton gin trash, a growing interest in looking after soil health and the continued industry commitment to improved technology. Here we highlight what is known about the benefits and problems for cotton

growers interested in using compost and examine the potential for the use of cotton gin trash in cotton systems in Australia.

Cotton gin trash

Cotton gin trash (CGT), a by-product of the ginning process, presents a significant waste disposal problem. This issue recently escalated when CGT was classified as hazardous by the NSW Department for Planning and Natural Resources (DIPNR) due to concerns about pesticide residues. The potential costs and implications of this classification were an obvious concern to the Australian ginning industry.

Fortunately, recent CRDC funded research resulted in the reclassification of CGT to solid waste, based on levels of chlorpyrifos. The reclassification was in accordance with DIPNR recommendations. The researchers (Crossan and Kennedy) also noted that residues of most crop-applied chemicals decomposed. Of the remainder, only a small amount of residue persisted and at levels low enough to not be considered as an ecological risk.

The gin has five options when disposing of CGT:

- Solid waste disposal;
- Spreading on soil;
- Composting;
- Incineration; and,
- Feeding to livestock.

But in Australia, environmental licensing precludes gins from burning, and the

detection of Helix (1994) and endosulfan (1998) in cattle stopped the use of CGT as a livestock feed. Since then, Helix has been removed from use and endosulfan is now more stringently regulated. This could facilitate the reconsideration of CGT as feed.

Of the remaining three options, landfill (both on and off site) and spreading are the most widely used, whilst composting, either by the gin or a commercial contractor, plays a minor role in Australia.

Composting and compost application

Compost is formed through the controlled biological decomposition of organic materials. The process requires water and reaches high temperatures. Much of the carbon is driven off and mineral nutrients are therefore concentrated in the remaining material in a reduced C:N ratio, making it a valuable fertiliser supplement.

But producing good compost is not easy. It requires a commitment of both time and money.

The process is self-starting and doesn't need the addition of microbes or cultures, but water, aeration and temperature are important and can have significant impacts on the speed of the process.

For good composting, a water content of about 60 per cent is recommended as well as aeration through either regular turning or forced air injection to control

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temperature. Most materials can be composted in three to seven weeks under optimal conditions.

Before embarking on a composting operation, there are several factors to consider including the source of the material to be composted (animal manure, crop residues, waste from fish and meat processing facilities, and domestic wastes, including sewage sludge). There are many sources of information on the suitability of different materials, comparing the initial and final product.

Efficient, on-farm composting:

- Suppresses soil-borne plant diseases and, depending on the material's source, removes potential human and animal pathogens;
- Sterilises viable weed seeds within the material;
- Converts organic waste to a more easily handled product (reduces volume by about 60 per cent and weight by about 50 per cent), thereby reducing storage and transport costs;
- Depending on waste material and management, composting can remove odours; and,
- Waste recycling to produce a potentially valuable commodity.

Compost application can:

- Replace nutrients and organic matter that have been removed from the farming system;
- Improve soil structure by adding organic matter; and,
- Recycle nutrients and reduce fertiliser requirements.

Potential drawbacks include:

- Considerable inputs of time, money, labour and equipment;
- Space for composting and storage of the final product;
- Odours if materials are not composted properly;
- Nutrients are in organic forms not readily available to plants;
- Adverse weather and other environmental conditions hampering the process; and,
- End product quality depends on source material and composting conditions.

A source of micro-organisms?

It is popularly believed that compost is a source of beneficial soil organisms that help crop growth but this is not so.

During the composting process, the microbiota undergoes extensive changes in both size and species abundance. These changes are predominantly governed by

temperature. During the initial warming stage (20–40°C), mesophilic bacteria and fungi dominate, but as the temperature rises (40–60°C) they are superseded by thermophilic bacteria and many of the fungi are lost before the mesophilic bacteria and fungi repopulate as the compost cools and cures.

Mature composts still have a diverse microbial fauna, but most of these do not survive when added to the soil. They are displaced by the native soil micro-organisms. But adding compost to the soil can encourage the native populations as they decompose the compost and use its nutrients. Adding compost can also increase nutrient turnover rates within the upper soil layers, which can stimulate more prolific crop root development. Unfortunately, adding compost may also stimulate pathogenic micro-organisms.

Using composts in cotton-growing systems

The source and method of compost production, soil type and the local environment may all affect lint yield from a compost-fertilised system. Applying compost as part of a farm's nutrient management program can increase field traffic leading

...48 ▷

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to higher application costs and potential compaction problems. Several commercial-scale trials have shown that composts may add little instantly available nutrient for the subsequent crop so chemical fertilisers are still needed.

Using cotton gin trash

In the United States, uncomposted CGT used as a soil-spread mulch has been extensively studied and demonstrated to cause significant increases in cotton yield when applied at rates from two to six tonnes per acre (six to 15 tonnes per hectare). The highest gains were obtained in dryland systems because of increased soil water holding capacity, physical structure improvement and better phosphorus and potassium nutrition.

But there are potential serious problems including weed seed survival, chemical residues, spread of fungal pathogen inoculum and inhibited cotton germination at high CGT application rates. Of special concern would be the spread of *Fusarium wilt* (Fov). These issues, while inhibiting the use of CGT directly on the land, can be alleviated by composting the CGT.

Composted CGT could act as a good long-term nutrient source, particularly for situations where plant-available potassium and phosphorus levels are limiting. The nitrogen content of the final product is increased with composting, although only seven to 30 per cent of this nitrogen is immediately available.

Animal manures and composted animal manures contain much higher levels (40–70 per cent) of available N. Viable weed seeds and fungal pathogens, including

Verticillium wilt, are destroyed during the composting process, as are many registered insecticide and herbicide chemicals.

In the US, the applications of composted CGT in cotton trials did not have the same associated yield benefits as seen with the use of raw CGT. Composted CGT applied at 20 tonnes per hectare showed no significant improvements in cotton yield.

But application and incorporation of composted CGT at a rate of 12.5 tonnes per hectare four weeks prior to planting and applications of 45 tonnes per hectare have significantly decreased cotton germination and emergence. Composted CGT has been added to potting soil mixtures with beneficial results on crops other than cotton in the USA.

CGT and worm composting in Australia

The Australian experience of CGT, compost and composted CGT for use as a soil amendment or fertiliser for cotton is limited to a few studies.

John Buckerfield's trial in 1998 investigated the application of one, two and five tonnes per hectare of vermicompost (worm-composting) and two tonnes per hectare of composted CGT or manure as a supplement to normal fertiliser addition over the first two years of a three-year trial.

Interestingly, yield increased (~15 per cent) in the first season but in the two subsequent years, compost amendments resulted in yield decreases of five and 25 per cent, respectively, due to poor plant establishment. The poor stand was not attributed to the added organic matter and Buckerfield's report suggested that more work was required before industry recommendations could be made, with growers

to consider small scale trials before adopting compost use.

Rochester and Constable in 1998 carried out an evaluation of Vermicast (a commercially composted domestic waste) applied in covered trenches at zero, 0.4, 0.8 and 1.6 tonnes per hectare. Results indicated a significant yield decrease of 0.63 bales per hectare in the Vermicast treatments, but this was not due to reduced establishment or nutrient uptake.

Grass weeds were observed to be a problem in the Vermicast treatments and it was hypothesised that root pathogens might also be involved in the yield reductions. Further study was again recommended especially on silty, hard setting, sodic or saline soils that may be more responsive to Vermicast.

There are many other compost alternatives and of these, compost teas and manures, particularly composted chicken manure, are being considered by some growers. But there is currently no evidence for either increased profitability or crop yield from the use of these products.

SUMMARY

The available evidence for Australian growers suggests that compost application is of little benefit and often deleterious to cotton production, but several gaps in the knowledge exist. No large scale trials involving several soil types have been done and no dollar value is available for improvements to soil properties from compost applications.

The US CGT and composting systems involved huge application rates compared to those trialled so far in the Australian system. The transport and spreading costs of 10–40 tonnes per hectare compost may make this practice uneconomical, in terms of fertiliser savings and yield increase. The widely reported impact on plant stand could be due to populations of *Rhizoctonia* or *Pythium* sp responding to compost application and increasing damping-off disease.

Finally, production of the large quantities of compost that could potentially be utilised by the cotton industry is not an easy task! A possible alternative for grower consideration under the current climate might be the use of green manure crops that add N, organic matter and reduce soil C decline.

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Cotton gin trash could be composted as a long term nutrient source.