Spent Mushroom Compost for Viticulture

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Field-trials have demonstrated the benefits of spent mushroom compost as a soil amendment for vineyards. Incorporated in the soil prior to vineyard establishment, the spent mushroom compost can increase the early growth of young vines. Used as a mulch or soil conditioner at low application rates, spent mushroom compost conserves soil moisture, improves soil structure, and improves conditions for vine growth and production. Like any type of organic matter used for vineyard soil improvement, the key to making this consistent, quality source of organic matter work, is to get the application rate right.

Interest in the use of compost in vineyards has increased over the past five years, with many growers considering these materials for improved irrigation management. Research has demonstrated the benefits of compost derived from green-organics for water-saving, weed-control, soil structural improvement, increased soil biological activity, uniform establishment of young plants, and management of yield and quality (Buckerfield & Webster, 2001, Buckerfield & Webster, 2002,).

Field-trials with green-organics compost in vineyards have been in place for up to seven years. Over forty experimental sites are located across Australia, encompassing a range of regions, varieties, climates and soils. Local factors are certainly important, but positive results in a range of conditions suggest there are some more basic principles at work. Protection of the soil surface with reduced fluctuations in soil moisture and temperature provides more favourable conditions for root-growth in the topsoil. When incorporated in the soil prior to new vineyard establishment, the compost can maintain "soft" soil and increase biological activity in the rootzone. We expect that these same principles will apply when spent mushroom compost is used as a soil amendment in viticulture. Results from field-trials with a range of composts suggest that choosing the right application rate for the grade (composition of particle sizes) of the compost is critical for achieving benefits and good value.

Spent Mushroom Compost

Spent Mushroom Compost has features which make it potentially more attractive for use as a soil amendment than other materials commonly used for increasing organic matter in viticultural soils:

Consistency – the disciplined compost production methods required for mushroom growing ensure a consistent spent compost, which conforms to specific conditions within the Australian Standard for Composts, Soil Conditioners and Mulches AS-4454 (Standards Australia, 1999). The material is known within the mushroom growing industry as “spent mushroom substrate”, and it must have grown a crop of mushrooms to be called this. Spent mushroom compost has a predictable quality from season to season, which sets it apart from alternatives such as straw and manure.

Pasteurization – the compost is pasteurised before, and in some mushroom production systems, after cropping. Along with the strict composting process, these pasteurisations provide further assurance of freedom from pathogens and weed propagules. The compost is particularly suited to sensitive applications, such as for soil incorporation at vineyard planting, where the compost will be in direct contact with the young vine roots.

Nutrient Value – with a relatively low ratio of carbon to nitrogen (around 15:1 for the material used in these experiments), the spent mushroom compost can be considered to have some nutritional value, making it valuable for soil incorporation at vineyard establishment. Levels of nutrients will vary according to the type of animal manure used in mushroom compost production.

Grade – we expect that with selection of appropriate application rates, spent mushroom compost has a grade making it suitable for both soil incorporation and surface application. The quality and consistency of the material makes it ideal for soil incorporation, where it will be in close contact with the root system. As a surface applied soil conditioner, the fine component will be readily incorporated in the soil through biological activity. The coarser fraction, consisting of small aggregates of undecomposed straw and peat moss, will provide residual surface protection for at least one growing season.

Vineyard establishment

Results of field-experimentation have demonstrated benefits in the establishment of newly planted vineyards where spent mushroom compost was incorporated in the soil prior to planting. In an Adelaide Hills vineyard, the compost was applied 50mm deep in a 500mm wide band along the marked vine rows, then rotivated into the soil to a depth of 200-250mm.

Young vines were 20% taller ten months after planting than control vines (Figure. 1). The taller vines had almost twice as much shoot growth above the height of the cordon wire, giving the grower more opportunity to establish the structure of the vines uniformly across the vineyard.

Vineyard soil remediation

Infiltration rate was increased by over 40% where spent mushroom compost was applied as a mulch to a young vineyard in the Clare Valley (Figure 2). Infiltration was increased from a rate we might expect from the soil type (well structured clay) to one we might expect to see in a deep sandy loam (Handreck & Black, 1994). This increased infiltration will assist in reducing the pooling of irrigation water under drippers, and reduce evaporation from the soil surface. In winter, the increased infiltration will allow storage of more rainfall in the soil and reduce movement of water across the surface, carrying soil and nutrients and potentially causing erosion. Already we have seen improved storage of winter rainfall, with higher soil moisture under the spent mushroom compost during September, ready for use by the vine during spring.

The increased infiltration was linked with increased earthworm activity; earthworm density was increased by 40% with spent mushroom compost (Figure 3). The additional burrowing activity has created channels for movement of water into the soil surface. Over time, we can expect the increased burrowing activity will also “soften” the soil, reducing soil strength, though twelve months after application, this effect had not yet been seen.

Earthworms were active above, the soil, working within the spent mushroom compost. The soil working species are associated with conditions suitable for root growth, and can be considered as "indicators" of good soil conditions for plant growth (Buckerfield & Auhl, 1994). Earthworms are sensitive to changes in the soil, and we have seen populations respond quickly, not always positively, to the application of a dense layer of organic matter (Webster & Buckerfield, 2002). That earthworms were active within the mulch so soon after application indicates the "safety" of this organic matter: spent mushroom compost would appear to have few toxicities with the potential to affect soil organisms, and therefore sensitive young plant roots.

However, earthworm activity within the mulch may be an indication of the potential for vine roots to also grow within the mulch. We view root growth within a mulch, above the soil surface, as a possible negative. With the roots above the soil surface, the mulching effect is lost, and the vines have access to a source of nutrients that the grower can not manage or control. We see the activity of earthworms in the spent mushroom compost as an indication that for use as a mulch or surface applied soil conditioner, low application rates will be most appropriate.

Yield & quality management

Results of field-experimentation have demonstrated opportunities to reduce irrigation while maintaining crop yield. In a trial with spent mushroom compost applied as a mulch 50mm deep under two year old Shiraz vines, an assessment of bunch numbers showed there were 20% more bunches at the first harvest after application (Figure 4).

At the next harvest, a 30% increase in yield was recorded (Figure 5), due largely to a 25% increase in bunch number (Figure 6). Bunch and berry size were not changed; increased yield has been a result of increased bunch number, or increased capacity of the vine, rather than a result of “pumped up” berries. There was no significant change in pH or TA, though TA appeared to be around 5% higher with spent mushroom compost (Figure 7). Juice sugar was reduced by 5% (Figure 8). In this experiment, we weren't able to optimise irrigation to specifically suit the mushroom compost treatment, so we suspect there may be further potential to manage the juice quality and vine "balance" with reduced irrigation. The increased yield in the second year would have resulted in an extra $4,200/ha in crop value (Phylloxera & Grape Industry Board, 2001).

Irrigation Management

Measurements of soil moisture in September showed there was 30% more winter rainfall stored in the top 30cm of the soil where a 50mm of spent mushroom compost had been applied (Figure 9). Acting as a mulch over winter, the spent mushroom compost had effectively conserved winter rainfall. We expect that the first irrigation could have been delayed for this vineyard, and that during the irrigation season, reductions of 20-30% may have been achieved.

We strongly encourage close monitoring of soil moisture as an important part of good vineyard organic matter management. There will be a need to adapt irrigation schedules both where compost is incorporated in the soil, and where it is used as a surface-applied soil amendment. Compost incorporated within the soil will increase water holding capacity; at this time of rapid root growth, good soil aeration will be needed, and excess moisture will exclude air. Used as a surface-applied amendment, the material will prevent evaporation of moisture from the soil surface, and encourage increased storage of winter rainfall through improved water-infiltration. Soil moisture is likely to be affected, and irrigation should be adjuste for management of quality at critical stages of fruit development.

Using spent mushroom compost

Genuine spent mushroom compost - ensure that the material being marketed as "spent mushroom compost" is indeed 100% spent mushroom compost. The quality, consistency and "safety" of compost "blends" which incorporate spent mushroom compost can not be assured. The compost must adhere to specific tests within the Australian Standard for Composts, Soil Conditioners and Mulches (AS-4454 1999) to be called spent mushroom compost. These tests ensure that the compost has supported a crop of mushrooms. The Australian Mushroom Growers Association (Ph: (02) 4577 6877) can advise on sources of 100% spent mushroom compost.

Soil incorporation - spent mushroom compost can be used as a "safe" source of organic matter for soil incorporation prior to vineyard establishment. Applications 50-75mm deep, applied 500mm wide along the vine row (85-120m^3/ha), can be cultivated into the soil to a depth of 200-250mm, to give a concentration in the soil of around 20-25%. Although there is no evidence to suggest any harm from higher application rates, there is also no evidence to suggest additional benefit, so we caution against exceeding 25% concentration in the soil.

Soil conditioner - spent mushroom compost can be used at low application rates as a surface-applied soil conditioner. Rates up to 25mm deep, 500mm wide undervine (up to 45m^3/ha) will provide valuable organic matter for soil improvement, and may be most appropriate where there is a desire to add organic matter to the soil

Mulch - the compost can be used at low application rates as a mulch. Rates between 25 and 50mm deep, 500mm wide undervine (45-85m^3/ha) can provide significant savings in irrigation and improve soil structure. Applications should not exceed 50mm depth to discourage excessive root growth within the mulch. Experimental results with other types of fine compost applied on the surface also suggest that rates higher than 50mm are unlikely to provide any additional benefit (Webster & Buckerfield, 2002).

Longevity - with the relatively low ratio of carbon to nitrogen and fine grade of the material, we can not expect the spent mushroom compost to persist on the soil surface for the four or five years we might expect from a coarsely textured 'green-organics' compost mulch. The material is likely to decompose rapidly. Incorporation of the mulch into the soil will be further hastened by the activity of earthworms, particularly as results suggest the compost is a food source favoured by earthworms.

We can report that the material used in the Clare Valley was still visible on the soil surface two years after application, but we can expect to see little evidence on the surface at soil monitoring next September, two and a half years after application. In higher rainfall climates, and on more fertile soils, decomposition is likely to be faster. The benefits to soil structure and water-saving are likely to persist for some years after the material is no longer evident on the soil surface.

Conclusions

Results of field experiments with spent mushroom compost as a soil conditioner have identified benefits to soils and plants:

- Improved growth of newly planted vines with spent mushroom compost incorporated in the soil prior to planting.
- Increased yield with spent mushroom compost as a mulch undervine, indicating a potential to reduce irrigation while maintaining and managing yield and quality.
- Increased infiltration, moisture holding and biological activity in soil with spent mushroom compost as a mulch undervine.

- The key to making organic matter work is to get the application rate right; for soil incorporation, application rates which give a concentration in the topsoil of around 20% may be appropriate.
- For surface application, results suggest low application rates will be most appropriate; up to 25mm depth as a soil conditioner, and up to 50mm depth as a mulch.

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Possible Captions

Figure 1 – Vine height (cm) ten months after spent mushroom compost was incorporated in the soil prior to planting.

Figure 2 – Infiltration rate (mm/hr) increased by 40% with spent mushroom compost as a mulch undervine.

Figure 3 – Earthworm density (nos/m2) in the soil and mulch, with spent mushroom compost undervine.

Figure 4 – Bunch number (per vine) at first harvest after application of spent mushroom compost as a mulch under vines.

Figure 5 – Yield (kg/vine) at second harvest after the application of spent mushroom compost as a mulch under vine eighteen months previously.

Figure 6 – Bunch number (per vine) at first harvest after application of spent mushroom compost as a mulch under vine eighteen months previously.

Figure 7 – Titratable acidity (g/L) of juice from vines where spent mushroom compost had been applied as a mulch eighteen months previously.

Figure 8 – Sugar content (°Brix) of juice from vines where spent mushroom compost had been applied as a mulch eighteen months previously.

Figure 9 – Soil moisture (%) at 0-30cm in the soil increased with spent mushroom compost as a mulch undervine.