

The Compost Column

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Biological control of *Phytophthora cinnamomi* (Root Rot)

John Menge, a professor of Plant Pathology from the University of California is a world leader in biological control research on the avocado root rot fungus, *Phytophthora cinnamomi*. He was recently invited to visit South Africa by Hans Merensky Holdings, and presented an overview of his work at Technical Days held in Natal and the Limpopo Province. This article contains a brief review on some work published on this subject.

Mulches and Gypsum

The use of mulches and biocontrol agents to control avocado root rot is not a new science. Broadbent and Baker first described the system in 1974 as the Ashburner method, making use of bulky organic mulches, chicken manure and a calcium source. Over time this system has been modified to use only the key ingredients, which according to John Menge are woody organic mulches and gypsum.

Effect of Composting Enzymes

Phytophthora cinnamomi, the avocado root rot fungus is a member of the Oomycete class of fungi. These fungi are unlike many other fungi, because their cell walls contain cellulose.

Woody mulches such as pine bark and wood chips are mostly composed of cellulose and lignin. The wood decay fungi growing in these mulches produce enzymes (cellulase, glucanase & laminarase) to break down the cellulose and lignin. These enzymes also destroy the cell walls of *P. cinnamomi* (Downer, 1998).

The cellulase enzyme is very effective within the mulch layer, down to the soil-mulch interface. Their effect does not extend into the soil, probably because they are adsorbed and deactivated by clay particles. Root rot and *P. cinnamomi* exist unaffected in the soil underneath the mulch (Menge *et al.*, 1999).

Types of Mulch

The type of mulch is very important, as some mulches can cause more harm than good. John Menge reported that uncomposted manures release ammonia, which can damage avocado roots. Heavy dosages of manure will first kill roots, before giving a nitrogen stimulated growth boost. Fresh manures should be applied sparingly, or spread over a coarse woody mulch.

It is recommended that bulky mulches with a high C:N ratio are used. These mulches will allow the growth of the beneficial wood decay fungi. Cellulase produced during the

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decomposition of mulches will also vary depending on the type. Preliminary results from a mulching trial in New Zealand, focusing on cellulase production revealed the highest cellulase activity in a *Eucalyptus* mulch (Faber & Spiers, 2003).

Physical properties such as particle size also affect the suitability of materials to be used as a mulch. Although wood chips and sawdust are both derived from wood, sawdust can't be utilized as a mulch. Sawdust has a larger surface area for microbial activity and will rapidly deplete soil nitrogen during the decomposition process. Sawdust also forms an impermeable barrier that will restrict the movement of water to the roots and soil below the mulch.

Calcium

Calcium has been found to be mildly toxic to *P. cinnamomi*. Menge (2002) postulates that calcium may reduce avocado root rot by:

- Stimulating root growth
- Increasing disease resistance
- Reducing the sporangial formation of *P. cinnamomi*
- Interfering with zoospore motility
- Improving soil drainage
- Stimulating antagonistic microorganisms

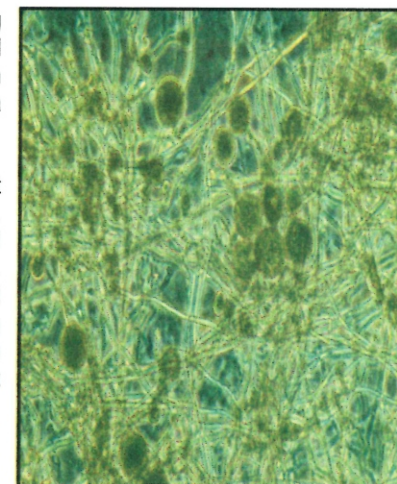
John Menge indicated that in California 1500 3000 kg of gypsum is applied per hectare, depending on tree size. Significant reductions in root rot have been reported when gypsum has been applied.

This is in contrast to Dr. Elaine Ingham's opinion on this subject. Elaine is President and Director of Soil Foodweb Inc., a company that advocates a number of techniques to improve the population and diversity of soil organisms in general. She presented courses in South Africa in April 2004 and feels that large applications of gypsum (> 100 kg / ha) cause various problems, including salt impact - osmotic shock (Ingham, 2004).

Mulch and / or Compost?

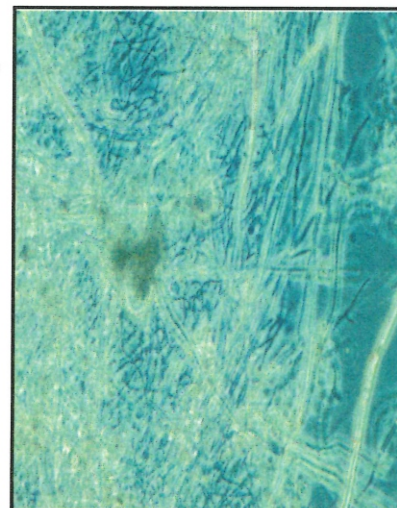
After John's presentation a number of growers are questioning whether they should be applying compost or mulch. I have tried to outline the benefits and shortfalls of mulches and composts in Table 1. There are however a lot of questions that we don't know all the answers for.

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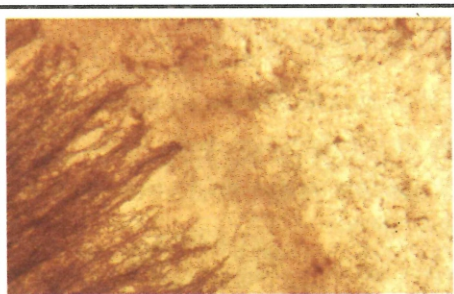
Healthy avocado root rot fungus

Photo: John Menge



Avocado root rot fungus in the vicinity of mulch wood decay fungus. (Note the reduction in numbers of dark sporangia on the hyphae)

Photo: John Menge



Wood decay fungus from mulch growing over avocado root rot fungus

Photo: John Menge

Table 1: Basic comparisons between the use of woody mulch and compost

Woody Mulch	Compost
Fungal Dominated (e.g. Wood decay fungi)	Complex biological diversity, the composition affected by raw materials and the composting process
Enzymes produced by wood decay fungi destroy <i>P. cinnamomi</i>	Cellulase activity in the compost probably dependent on the amount of cellulose still present. (How long are the enzymes active?)
Possible beneficial affect from by-products of the decomposition process (?)	Possible beneficial affect from other antagonistic micro-organisms, and by-products (?)
Very limited source of nutrition	Valuable source of nutrition
Helps to conserve soil moisture	Heavy applications will help conserve soil moisture
Helps improve soil structure, infiltration and water-holding capacity	Helps improve soil structure, infiltration and water-holding capacity
Weed suppression	Thick layers help suppress weeds
Cheaper than compost	More expensive than mulching
Certain materials are not suitable for mulching (e.g. Sawdust and other waste products)	Some materials unsuitable for mulching could be utilized in compost

Conclusion

Growers should ask themselves why they want to apply compost and/or mulch. It will be beneficial to use woody mulches to help control root rot and conserve soil moisture,

and compost to improve the soil's microbiology and provide nutrition. Immature compost with lots of cellulose still present may be more beneficial in terms of root rot control than mature compost with lower cellulose content. *Continued on page 11*

Cellulase is only one of the many by-products associated with decomposition. Cellulase has been shown to be effective at suppressing *P. cinnamomi*, but its effect is limited to the mulch and the soil-mulch interface. It is possible that there are other by-products of decomposition, and compost microorganisms that inhibit the growth of *P. cinnamomi*. A trial comparing the effect of woody mulches and composts, taking costs into account could reveal some answers.

References:

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A course grassy mulch is applied to a replant tree at Goedgelegen Estate



Heavy compost application (> 200 m³ / ha)