

Advantages of organic mulches in the orchard

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Manure, compost, woodchips, slashed material and pruned branches are commonly used as organic mulches in the litchi orchard¹. There are many agricultural advantages to correctly applied organic mulches in the soil^{2,3}. These advantages include the presence of natural *micro-organisms* that enhances plant growth, plant health and product quality^{1,4,5}. Micro-organisms generally include bacteria, fungi, viruses and algae⁶.

Actinomycetes are a remarkable group of bacteria that provide us with antibiotics we use in medicine today (*Streptomyces*). Some bacteria work symbiotically with non-legumes as nitrogen fixing bacteria (*Frankia*) and others such as *Clostridium*, *Azotobacter* or *Bacillus* are free-living nitrogen fixers. Nitrification is the aerobic process in which bacteria (*Nitrosomonas* & *Nitrobacter*) transform Nitrogen in the form of applied ammonia to nitrite followed by the oxidation of the nitrite to nitrate which is available for plant uptake. Nitrogen fixing bacteria also bind the nitrogen that is available in the atmosphere into a form that the plant can use. The oxidation process of sulphur that is important for crop production are also driven by bacteria^{6,7}.

Bacteria act as decomposers of plant material (cellulose and lignin) and insect exoskeletons. The 'eathy' smell of turned healthy fresh soil is a sign of decomposing bacteria at work. Decomposing bacteria feed on organic mulches and make nutrients available for uptake into the plant. Table 1 lists the factors and practices that may add to the organic mulch content in soil or lead to organic mulch degradation.

Table 1 Factors and practices that influence organic matter contents in the soil⁸.

Positive factors and practices	Negative factors and practices
Conservation farming practices	Conventional farming practices
Pruned material remain in the orchard	Remove pruned branches from orchard
Cover crops	Erosion of top soil
Low soil temperatures and shade	High soil temperatures and exposure to direct sun
High soil moisture content	Dry soil
Surface cover	Burnt vegetation
Compost and manure application	Inorganic fertilizers
Adequate nitrogen	Too much nitrogen
High plant productivity	Low plant productivity
High root : above ground plant material ratio	Low root : above ground plant material ratio

The addition of manure and compost to soil will raise the soil carbon content and result in unlocking valuable plant nutrients through decomposition. Mulches should ideally have a

carbon: nitrogen ration between 25 - 100: 1. **BEWARE** the problems that can develop due to the injudicious application of compost and manure containing high phosphate (P) levels. Some guidelines when selecting compost and manure include the following:

- (1) Analyse the compost and manures to determine the nutrient levels.
- (2) Do not exceed the recommended nutrient application rates.
- (3) Determine if the fruit buyer or market will allow manure applications.
- (4) Avoid manure applications where soil P levels are high (> 75ppm, Bray 1 method).
- (5) Prevent manure and compost losses to surface and ground water.
- (6) Use composted manure that will contribute to the organic matter content of the soil.

One of the most important roles bacteria play in our soils are decomposition^{3,7}. Carbon is an important food source for micro-organisms. In the soil, the organic matter content is 1.72 times the organic carbon content⁹. Carbon dioxide readily available in the atmosphere and biosphere are the biggest source of carbon in the soil. Other important sources of carbon can be grouped into live material, dead material and composed material⁹. Live material such as earthworms, plant roots and micro-organisms forms between 2 - 15% of the organic carbon source in the soil. A few recent articles listed the benefits of cover crops as live mulches. Some of the benefits include improved soil fertility, improved soil structure, better water management, reduced soil erosion, trap-crops for controlling pests and diseases and reduced weed pressure¹⁰ which in turn reduce the use of herbicides¹¹ and promote of earthworms in the soil¹².

Bacteria also plays an important role in the break-down of herbicides in the soil so that the concentrations does not reach poisonous soil levels. Bacteria populations excrete substances that aggregate small quantities of soil. This improves the soil structure which in turn increases the infiltration rate of water into the soil and aeration in the soil. Soil aeration forms a critical part of root and plant health.

Fungi that live in a mutualistic relationship with plants (e.g. *Mycorrhiza* and *Trichoderma*) are naturally occurring micro-organisms that can suppress plant pathogens such as *Phytophthora* and *Botritis*. These mutualistic fungi live inside roots or form a sheath on the root surface. They compete for space and nutrients with pathogens in and around the plant roots. Mycorrhizas also extend into areas which are often not within reach of plant roots, and thereby increase the total surface area that roots utilise as nutrient resources and water uptake. In turn, the plant provides the fungus with carbohydrates. *Phytophthora* species are oomycetes, and not fungi. Beneficial micro-organisms can also produce enzymes (cellulases and glucanases) that digest celluloses and glucan molecules in *Phytophthora* cell walls². Indeed, mulching is used to control *Phytophthora cinnamomi* root rot in avocado and is beneficial for the development and reproduction of microbial organisms that are antagonistic to *Phytophthora cinnamomi*¹³.

The application of organic mulches has also been proven to increase earthworm populations¹⁴. The role of earthworms in the soil are:

- (1) Earthworms consume and digest organic litter, and excrete it in the form of nutrient-rich humus.
- (2) Take soil particles and organic material deeper into the soil where decomposed nutrients are made available to the deeper roots of plants.

- (3) Improve soil structure, aeration and drainage, which in turn can reduce soil compaction and crusting.

Another advantage of mulching is a reduced tree stress. A mulch layer serve as a temperature buffer since it reduces soil exposure to direct sunlight and consequently overheating of plant roots. In winter, mulches can result in warmer soil temperatures that allows for longer daily growth periods and earlier spring flushes². Mulches significantly reduce evaporative water loss from the soil surface, improves soil permeability, biodiversity and significantly reduce soil compaction^{1,9,13}. It is important to note that irrigation practices should be amended where mulches are applied in order to prevent waterlogged conditions that will promote anaerobic bacterial growth which has negative effects on plant health and pathogen related problems such as *Phytophthora* infection and root death due to hypoxic (no oxygen) conditions². In a recent presentation at the South African Avocado Growers Organizations' Research Symposium, Schoeman & Nortjé provided proof for the alleviating effect of 2L/m² compost (costing R 3 600/ha) or 2g/m² polyacrylamide (costing R 312/ha) on soil crusting. Soil crusting results in oxygen negative conditions¹⁵ and *Phytophthora* infection is a result of soil compaction¹⁶, while aeration increases nutrient availability and uptake and reduced nitrogen losses¹⁷.

Sustainable farming orientated table grape growers in the Western Cape saved 15 - 20% water and their nitrogen application costs reduced with 40% due to the increased soil carbon levels following mulches. In addition, their herbicide usage reduced with 65% even though the labour costs increased¹². In summary, organic mulches plays an important role in biological, physical and chemical soil characterization. Mulches promotes an environment that beneficially affects plant health and product quality. Cultivated litchis that originate from areas where the decomposed organic mulch layers occur naturally beneath the plants, will benefit from well aerated soils that contain high levels of organic mulch.

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