MULCHES: GOOD OR BAD?

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To some farmers the term "mulch" stirs positive emotions, while for others the response is less enthusiastic. There are numerous literature reports of the benefits of mulches not only for their nutritional value, but also for disease control. But how do mulches improve avocado tree health, or control diseases, and do they have a downside? This article will attempt to address some of these questions. It is important to note that there are two types of mulches, namely plastic mulches and organic mulches, and for the purpose of this article, I will refer to mulch as "organic plant material".

Advantages of mulching

Natural microorganisms

It is well known that organic material is an important nutrient source; however, what is not often thought of is the influence organic material has on natural soil microorganisms, which can enhance avocado plant health both directly and indirectly. Microorganisms are required to decompose organic material in order to make nitrogen and various other elements available to plants. The soil is occupied by thousands of such beneficial bacterial and fungal species, but often these organisms are present in dormant forms and only become active upon favourable environmental conditions, of which nutrient resources form a part. Naturally occurring microorganisms also suppress pathogens - either by the production of antimicrobial compounds, or by competing for space and nutrients. For instance, when a plant root surface is colonised by thousands of bacterial and fungal colonies, a pathogen often finds it difficult to establish itself, which then reduces the amount and severity of infection. This is why fungicides and other chemicals (such as quaternary ammonium compounds which can kill both beneficial as well as pathogenic microorganisms) should be used with great care, and only when absolutely necessary.

Mycorrhiza

Several fungi are able to live in mutualistic relationships with plants and are termed mycorrhiza. Two types of mycorrhizas exist, namely arbuscular mycorrhizal fungi and ectomycorrhizal fungi. The former grow intercellularly into roots of plants (usually through root hairs), whereas the latter form sheaths around the surface of roots. Avocado roots lack root hairs, and ectomycorrhizal fungi are expected to occur on avocado roots. Mycorrhizal inoculation of micropropagated avocado cuttings have been demonstrated to enhance plant growth[1]. Mycorrhizae extend to areas which are often not within reach of plant roots, and thereby increase the total surface area that roots can in effect utilise as nutrient sources and water uptake. In turn, the plant provides the fungus with carbohydrates. By increasing a soil's organic content (i.e. mulching), these microorganism populations will also increase[2].

Phytophthora *control*

Root rot of avocado, caused by *Phytophthora cinnamomi*, is a major

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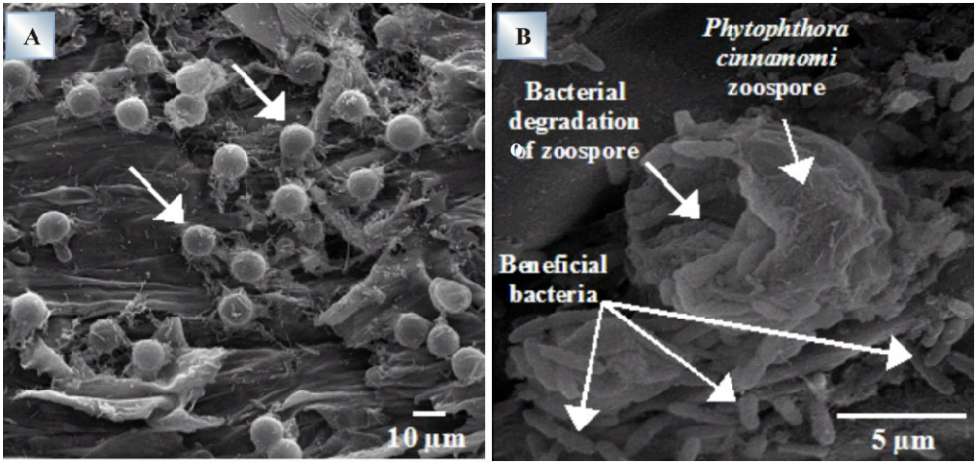

*Figure 1. **A**. Phytophthora cinnamomi zoospore cysts on an avocado feeder root surface (arrows).*
***B**. Degradation of a Phytophthora cinnamomi zoospore by bacteria that naturally occur in soil (Photos: Barry Christie)*

limitation to avocado production. Mulching is a non-chemical means of controlling *Phytophthora* populations in soils [3,4]. *Phytophthora* species are oomycetes, (Kingdom Stramenopiles) and not fungi as commonly thought. This is because fungal cell walls are composed of chitin (the same protein insect skeletons are composed of), whereas *Phytophthora* cell walls consist of cellulose and glucan linkages (the same molecules that are present in plant cell walls). As mentioned, natural soil microorganisms increase when mulch is added to a soil. These microorganisms produce enzymes (cellulases and glucanases) which digest the plant material, but fortunately, these same enzymes are able to digest the celluloses and glucan molecules in *Phytophthora* as well, and thereby inhibit pathogen growth. Figure 1 illustrates naturally-occurring bacteria in soil that are busy degrading a *Phytophthora cinnamomi* zoospore on an avocado root, and emphasises the importance of creating favourable conditions for these microorganisms. Mulching is thus crucial for the control of *Phytophthora* species, although it is important to note that mulching will only be effective when other practices such as irrigation and fertilisation are properly managed.

Zoospores are motile spores that are produced by Phytophthora *species (the causal agent of root rot and trunk cankers), and are able to swim in water. These spores can locate plant roots through chemotaxis (a phenomenon which enables microorganisms to be attracted towards certain chemicals or nutrient sources).*

Nutrient source

Large trees often create natural mulches by leaf drop,

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but additional mulch is often needed especially in young orchards. Avocado trees obtain most of their nutrients through feeder roots, which grow superficially between and into organic material just above and below the soil surface. By increasing the mulch content under an avocado tree canopy, more roots can be produced and consequently a healthier tree will result. Additional roots may in turn also reduce the effect that *P. cinnamomi* will have on a tree, since a constant production of new feeder roots will reduce the severity of root rot symptoms.

Earthworms

The application of mulch has been shown to increase earthworm populations[5]. School biology teaches the importance of earthworms in soils, but this basic fact is often forgotten. Earthworms consume and digest organic litter, and excrete it in the form of nutrient-rich humus. Secondly, soil particles, as well as organic material, are taken deeper into the soil (bioturbation) where these nutrients are made available to the roots of plants. Finally, earthworms improve soil structure, aeration and drainage, which in turn can also reduce soil compaction.

Soil moisture and temperature

Evaporative losses can greatly be reduced by mulching, and consequently water can be saved. Irrigation should therefore be reduced to avoid waterlogged conditions, that will promote root rot infection. Mulches also serve as temperature buffers, since it reduces soil exposure to direct sunlight and consequently overheating of plant roots, which would be detrimental to the roots. In winter, mulches serve to increase soil temperature, and the warmer soil allows for an earlier spring flush growth.

Disadvantages of mulching

We have discussed the positive effects of mulches, but are there any negative effects? Indeed! Often, pathogens can survive in dead organic material and in such cases, mulch could be detrimental to the crop, especially if the possibility exists that mulches could host undescribed/unknown pathogens. One example of a common pathogen that survives in mulch is *Neofusicoccum parvum* (formerly known as *Botryosphaeria parva*), which is the causal agent of stem cankers as well as stem end rot. It is thus recommended that a clear space is left around the trunk of each tree to limit the incidence of cankers. As mentioned above, mulching will reduce evaporation of soil water, and wet soils can enhance *Phytophthora* infection as well as cause hypoxia (oxygen starvation of roots). It is therefore crucial to reduce irrigation frequency and volumes where mulch has been applied.

Conclusion

It is clear that mulch in an orchard has many advantages as well as a few possible disadvantages. The negative aspects can be managed by modifying irrigation scheduling and taking care not to include known diseased material in a mulch. Overall, mulching will aid in reducing tree stress, which will enable trees to withstand pathogen infections to a greater extent. Mulching an orchard can be laborious, but, at the end of the day, all the effort will ensure that the farmer reaps the fruit of his labour, both literally and figuratively.

References

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