Mycorrhizae – And Olives

By: Jeff Transeau – Charta Olive Farms, Columbus, Texas

With big changes on the horizon for the Texas Olive Oil Industry it is quickly becoming important to discuss some of the new growing methods available to the olive producer. One of the most important new developments is the rise of organic methods of production. One of the most significant of these new developments is the ability of nursery owners and growers alike to be able to "inoculate" their trees to help protect them from harsh conditions in the soil. Research has proven that one such inoculation (Mycorrhizae) has the potential to dramatically alter olive production in our state.

Let me begin with the definition. The word "Mycorrhizae" is derived from the Greek - myco meaning fungi and rrhizae meaning roots. Therefore, Mycorrhizae is a group of fungi which inhabit the root systems of higher plants. Mycorrhizae fungi are not parasites. They are symbiots. They set up house in the root systems of higher plants and utilize the plants ability to withdraw nutrient matter from the soil. The fungi are able to aid the plant in the breakdown of the complex nutrient material. This system allows both fungi and plant to benefit. In the simplest terms, the fungi feed on the nutrients and take in plant by-products, mainly carbon and then aid in the breakdown of nutrients at the molecular level. The result is molecules and compounds, with phosphorous being the most prominent, that are more easily utilized by the plant. How all of this happens is an organic chemistry nightmare best left to those who derive some enjoyment from the analysis of such systems.

Mycorrhizae fungi are one of, if not the most historically significant group of organisms on planet earth. Many researchers believe that the tolerance of saline conditions (salt) in higher plants lies in the symbiotic relationship of plant and fungi. About 1 billion years ago simple organisms began to emerge from the seas to colonize the land masses. The fossil record indicates that even then they may have been closely aligned with fungi. Tests today indicate that

higher plants “infected” with mycorrhizae fungi are significantly more tolerant of heavy saline conditions and higher pH soils than those plants that are not associated with the fungi. This is how, some researchers say, the higher plants were able to colonize the land and eventually become significant land based organisms. So, if I may extrapolate, the reason you are here on this planet is partially because of mycorrhizae fungi.

Mycorrhizae fungi are divided into two main groups – Ectomycorrhizae and Endomycorrhizae. Our discussion will be limited to the endomycorrhizae. The Ectomycorrhizae are chiefly inhabitants of the major forests and are associated with those species. We shall further limit our discussion to the subgroup of endomycorrhizae which form shrub-like penetrations of the root hairs. The name given to this group is Arbuscular Mycorrhizae Fungi (AMF). This is the economically important group and they are associated with almost 80% of all the higher plants on earth.

Now that we know what these fungi can do, it is time to discuss how they can benefit us directly as producers of olive oil/table olives. The European olive (*Olea europaea L.)* has typically been grown in the arid or semi-arid regions surrounding the Mediterranean Sea. Because of the geographical distribution of the European Olive most researchers believe that the association of AMF and the olive has probably been on a minimal basis. Research of wild populations though is indicating that where there has been a robust association with the fungi, olives have prospered.

Arbuscular Mycorrhizae Fungi (AMF) colonize the roots of agricultural plants and promote the uptake of nutrients, provide some root pathogen barriers and aid in the transport of water into the plant. In return, the fungi utilize carbon and various other elements produced by the olive tree. Therefore, the fungi have a pervasive effect upon the plant form and function.

Let us examine these claims. There is scientific evidence that the association with AMF promotes the uptake of nutrients. Most of the studies have indicated that AMF plays a significant role in the uptake of phosphorous. Phosphorous is

an element that is very immobile in most soils. So, even with the addition of organic phosphorous, it quickly reacts with other elements in the soils to become calcium phosphate or other fixed forms. This benefit alone would make inoculation with the AMF worthwhile, but we don't stop there. AMF act as extensions of the plant root structure. This attribute enables the plant to significantly increase its surface area in contact with the soil. This attribute in turn, greatly increases the amount of nutrients and micronutrients that become available to the plant.

In controlled experiments, using rooted cuttings of *Olea europaea L*. varieties Frantoio, Moriaolo and Leccino were inoculated with MycoApply® AMF and compared with non-inoculated control cuttings. After 6 months the control and inoculated cuttings were analyzed. The results indicated that the MycoApply®AMF cuttings had significantly more root development. Depending upon variety, 15%-20% greater root structure was observed. The larger root structure also translated into greater development of the aerial compartment. Unquestionably, the inoculated cuttings showed a significant increase in plant growth.

In addition to nutrient uptake, AMF have been proven to increase the plants root hydraulic conductivity. This enables the plant to use water more efficiently, minimizing the stress associated with drought conditions. Studies with olives and grapevines indicate that plants with roots that have been inoculated with AMF have the ability to take moderate to severe water stress during which time non-

inoculated plants showed obvious signs of stress. The ability to effectively utilize soil moisture provides the olive producer with a far greater range of soils in which to plant trees within arid or semi-arid communities. For orchards with well developed irrigation systems, the ability of the plants to 'handle" less watering, often means significant savings from pumping less water. The ecological benefits from using less water, even from modest drip irrigation systems, has some obvious secondary benefits.

Now that we know that inoculation promotes plant growth in the laboratory, is it possible to get the same results in the field? Studies in several olive nurseries have shown that inoculated olive plantlets in the nursery performed just as well as in the laboratory. One study showed that three sets of plantlets, one with fertilizer, one without fertilizer and one with AMF inoculation only were compared for growth characteristics. The olive trees inoculated with AMF showed consistently higher growth than even the plantlets with fertilizer. In addition, the inoculated plantlets showed higher levels of potassium and phosphorous deposited in the leaves and shoots. Many nurseries in Europe and Israel are now inoculating their plantlets early and have abandoned the inorganic fertilization of nursery stock.

In field grown trees, the Israelis and others have experimented with the injection of inoculum into the drip irrigation system. Early results have indicated surprising gains in both plant growth and in the olives ability to resist drought and saline soil conditions. Trials of AMF injection into field trees are underway in many olive producing countries. Many researchers involved in these studies are confident that the AMF in conjunction with beneficial bacteria will also provide some protection for the plants from soil borne pathogens.

Below are pictures sent from Israel by a grower participating in trials of field inoculation of AMF. The field trees were planted from 4" pots with trees (whips) approximately one meter in height. The trees were injected with inoculum and allowed to grow for 17 months prior to these photos.

The inoculated trees shown in the photo are now 2.5 meters (8') tall with calipers at nearly 3". Researchers and growers alike claim inoculated trees have some 15% to 25% more growth in both aerial and root compartments in a given period of time than with non-inoculated trees. Those same growers are reporting the use of 20% less water during irrigation and significantly less problems during drought periods and with soil borne pathogens. Trials of flowering plants have also indicated a significant increase in bud and flower production that many attribute to the plants increased levels of potassium and phosphorous in the leaves and shoots.

Arbuscular Mycorrhizal Fungi are known to increase the root absorption zone and provide the foundation for a healthy soil structure. This results in increased uptake of nutrients, especially phosphorus and contributes to the plant's overall resistance to environmental stresses, caused by soil salinity, high pH and soil-borne pathogens. Our conclusions are that there exists sound scientific evidence for the inoculation of nursery stock and field grown olive trees. The use of Arbuscular Mycorrhizae Fungi inoculum in field grown trees is especially important in South Texas where relatively poor soils, drought stress and increasing soil borne pathogens are a common factor that all olive growers are faced with on a daily basis.