Inoculation of Almond Rootstock with Symbiotic Arbuscular Mycorrhizal Fungi

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Objectives:

1. Determine if there is value in adding AM fungi inoculum, particularly at planting of bare root (field grown) and the potted-plant nursery stock.
2. Determine if pre-plant fumigation impacts the extent and nature of mycorrhizal populations in the soil and is this of consequence?
3. Characterize the mycorrhizal fungi populations present on field grown nursery stock vs. potted plants at the time of planting and during the first season after planting as well as resulting tree performance

Interpretive Summary:

Soil borne arbuscular mycorrhizal (AM) fungus forms a symbiotic (mutualistic) relationship with most plants. The fungus colonizes the root and grows out into the soil. Hyphae net work, the part of the fungus that's in the soil acts as an extension of the root

system. The AM symbiosis improves plant phosphorus, nitrogen and mineral nutrition. Evidence also suggests the symbiosis provides protection of the plant against pathogens and improves plant water relations. In addition to facilitating nutrient uptake, some mycorrhizae secrete a gluey substance, called glomalin, which helps develop soil structure and soil aggregation favorable for plant growth. The AM fungus cannot multiply by itself. *Therefore innoculum production of AM is a challenge for the utilization of this fungus.*

Yet the status of AM fungal population in almond orchard is not well understood. The purpose of this study is to determine if specific practices associated with planting almonds (e.g., pre-plant fumigation, inoculation with AM fungus, or other factors like choice of field grown vs. potted nursery stock) have an impact on AM fungal populations to the extent subsequent tree performance is affected.

In August 2007 root samples were collected from an existing fumigation plot (Firebaugh, CA) in which trees were planted January 2007. Trap cultures of Sudan grass were established to multiply the residual AM fungus. A special nutrient medium was applied to irrigate Sudangrass for boosting AM inoculum production. AM spores were produced in January 2008 and used to inoculate almond rootstocks planted in Parlier, CA.

A field trial was initiated in early 2008 to examine the effects of Arbuscular Mycorrhizal (AM) fungi on almond tree growth. The trial was planted on 7 February 2008 at the USDA ARS San Joaquin Valley Agricultural Sciences Center. Trees used in the study were either traditional bare root (1/2" caliper) Nonpareil/Nemaguard or 3/8" caliper 'potted' Nonpareil/Nemaguard trees. Three AM treatments were imposed on the bare root trees (control, field cultured AM and commercial cultured AM) and potted trees were utilized as either controls, or field cultured AM (five total tree treatments).

The trial site had been previously (September 2007) strip fumigated (chloropicrin) to provide ten single blocks (five fumigated, five non-fumigated), randomly arranged in two 5-block rows. Each block was of sufficient length to accommodate 12 trees planted at 12 ft intervals. Pairs of trees for each treatment were planted in a randomized order for each block, with a single Monterey/Nemaguard tree at the ends of each block. In addition to being guard or border trees, the Monterey/Nemaguard trees were planted to provide adequate pollination of the trial trees in future harvests.

Trunk caliper was measured four times (40, 140, 180, 240 days after planting) during the 2008 growing season to provide an indication of relative tree growth. No tree deaths were noted in the trial during the first growing season. There were however, significant differences in tree growth depending on fumigation status of the soil, and other experimental factors.

Figure 1 illustrates the observed significance of the experimental planting's main effects at the four data collection dates during the 2008 growing season. The most visually evident differences in tree growth were between fumigated and non-fumigated plots. Pre-plant soil fumigation did not affect tree caliper significantly at 40 DAP, but was a highly significant main effect from 140 through 240 DAP. Tree type (bare root vs.

potted) affected trunk caliper throughout the 2008 growing season, being a highly significant main effect from 40 days after planting (DAP) onward. No significant differences in trunk caliper were noted between AM treated and control trees at 40, 140 or 180 DAP. However, trunk caliper differed between AM treated and control trees at 240 DAP.

Performance evalution will be continued for at least two years. *Colonization by AM fungi causes a decrease of plant growth initially according to some published literatures*.

Roots of Sudan grass from trap cultures were analyzed for AM fungal colonization in fumigated and non-fumigated soils. Sudan grass plants were grown under limiting phosphate nutrient conditions for boosting colonization and inoculum production. Five hundred and fifty root fragments (I cm long) were stained with trypan blue and scored for colonization. 60% of the roots from *non-fumigated* soil were colonized. About 40% of the roots from fumigated soil were colonized. The data indicate that fumigation did reduce residual soil AM population. Results from PCR and gel electrophoresis analysis indicate that *Glomus Mosseae*, *Glomus 3*, *Gigasproa rosea*, *Glomus intraradices* were present in the soil and in colonized roots of Sudamgrass.

Root samples from planted almond tress in Parlier will be collected for evaluating root colonization in November, 2008. Soil samples will be collected for nutrient analysis and population of arbuscular mycorrhizal spores.

Recent literatural review suggests the multifunctional nature of AM fungi includes better nutrient uptake, mineralization of organic nutrients, improving host plant's resistance to drought, seedling establishment, pathogen resistance, increased herbivore tolerance, increased pollination, heavy metal tolerance and increased soil stability. Research shows that AM fungi functioning may be more complex than previously thought. A diversified population of the symbiotic AM fungi in the soil in association with roots is important factor contributing to these beneficial effects.

Fig. 1. Almond tree growth measured by trunk caliper