Almond Mycorrhizal Inoculation Increases Root Mass and Decreases Plant Moisture Stress

David Steinfeld and Tom Lyke

Establishing almond seedlings on sites where water is limiting will reduce the size and vigor of an orchard plantation and subsequently lengthen the period of time to almond production. This study found that almond seedlings inoculated with mycorrhizal inoculum exhibited a greater capacity to withstand drought conditions during early plant establishment. These findings suggest that on sites where rainfall is low or irrigation is intermittent, inoculating seedlings prior to planting in a nursery or orchard site would be beneficial.

Methods

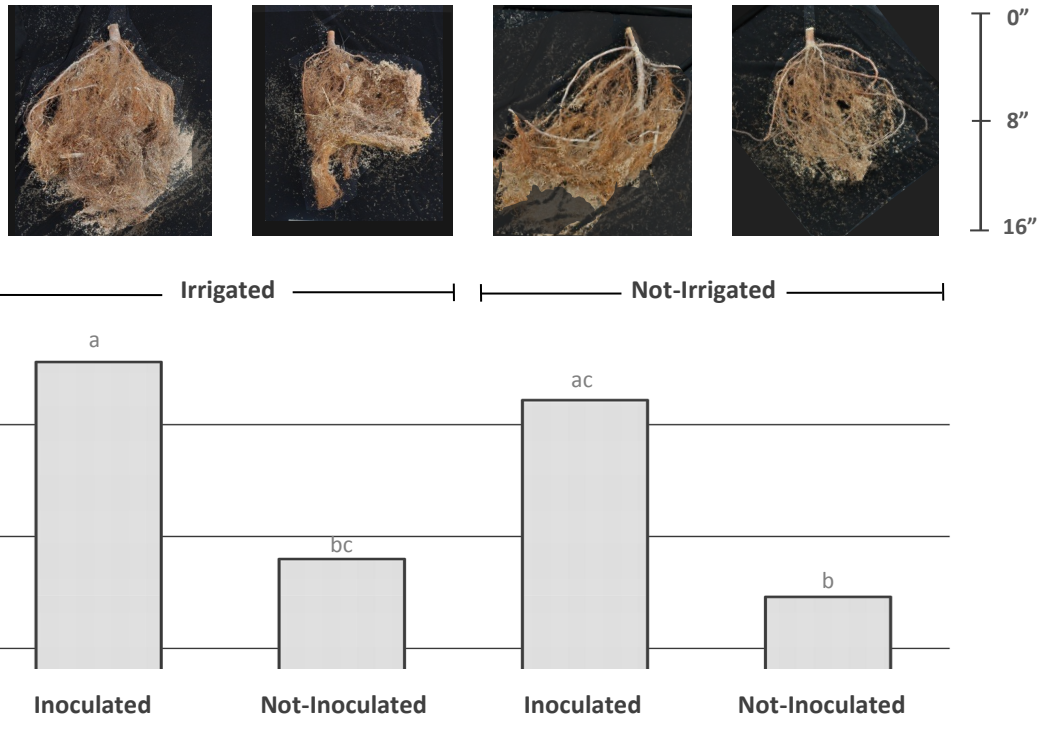
Almond seedlings were planted into 16 large grow bags containing 1,000 pounds of granular Attapulgite clay as a sterile growing media at the Mycorrhizal Applications, Inc. facilities in Grants Pass Oregon. One application of organic fertilizer (Nature Safe 8-3-5) was mixed into the media at a rate of 0.8 pounds per bag. Two seedlings were randomly assigned to each grow bag for a total of 32 seedlings in the study. Prior to planting, MycoApply® Ultrafine Endo mycorrhizal inoculum was applied to the roots of half of the seedlings at a rate of 50 grams each. Grow bags were then placed outdoors into four replicated blocks, each with two bags of mycorrhizal treated seedlings and two bags of untreated seedlings, for a total of four bags per replicated block.

Seedlings were planted June 13, 2014 and grown under the same irrigation regime until August 4, at which time one bag of mycorrhizal treated seedlings and one bag of non-mycorrhizal treated seedlings ceased to be irrigated for the remainder of the study. Weather during that period was hot and dry with average afternoon temperatures exceeding 90°F and precipitation less than 0.1 inch.

Seedling height and caliper measurements were taken on all seedlings at weekly intervals during August and September. In addition, during that period, pre-dawn Plant Moisture Stress (PMS) was measured on one seedling from each bag at one week intervals. On September 24, each grow bag was lifted with a fork lift and the bottom cut to allow media to flow out of the bag leaving the roots intact. Roots and shoots of each seedling were cut, dried, and weighed. A subsample of roots were evaluated for presence of mycorrhizal colonization using methods outlined in Brundett and others (1996).

Caliper, height, dry weight of shoots and roots, and PMS measurements were analyzed using a one-way ANOVA and Tukey HSD to determine if there were significant differences between means of each treatment.

Fig 1



Treatments with different letters are significantly different (*P<=0.1*) as determined by one-way ANOVA.

Results

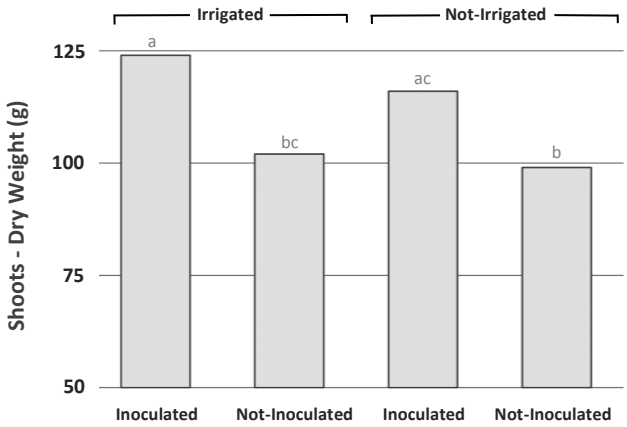
Dry root weights were 47% greater for seedlings inoculated with MycoApply® ultrafine endo mycorrhizal inoculum and irrigated over seedlings that were not inoculated and not irrigated (Fig 1). Roots of inoculated/irrigated seedlings were also 37% greater than seedlings that were not inoculated but irrigated. Dry shoot weights between treatments were similar in differences to root weights with Inoculated/Irrigated and Inoculated/Non-Irrigated treatments significantly greater than Non-Inoculated/Non-Irrigated treatment (Fig 2). Seedling heights were only significantly greater for the Irrigated/Inoculated treatment over the other three treatments. There were no significant differences in caliper measurements.

The plant moisture stress (PMS) test measures the amount of stress required of a seedling to pull water from the soil. A high PMS reading indicates that a seedling is under high moisture stress. Treatments that were not irrigated began to show significantly higher PMS values two weeks after the last irrigation. By September 11, these differences were dramatic, with non-inoculated seedlings approaching 40 bars PMS, which is often indicative of lethal conditions depending on the weather and duration of the drought. Inoculated seedlings, on the other hand, averaged 25 bars for the same dates.

Discussion

This study demonstrated that seedlings inoculated with mycorrhizal inoculum have greater shoot and root growth than seedlings not inoculated whether grown under low moisture stress conditions (irrigated) or high moisture stress conditions (not irrigated). These findings are important for almond growers who are establishing new orchards in areas where seedlings must withstand periods of drought. Seedlings with larger and more vigorous mycorrhizal colonized root systems will be under less moisture stress and become established sooner resulting in earlier almond production.

Fig 2



Treatments with different letters are significantly different (P<=0.1) by one-way ANOVA

Managers cannot depend on seedlings to become colonized with resident mycorrhizal populations either in the nursery or when outplanted in orchard fields. This study showed that seedlings inoculated with mycorrhizae had very high rates of root colonization, whereas seedlings that were not inoculated had very low rates. For the nursery or orchard manager, these findings suggest that a simple means of being sure that seedlings are colonized with mycorrhizae is to apply a mycorrhizal inoculum to root systems when a seedling is being transplanted in a nursery or in an orchard.

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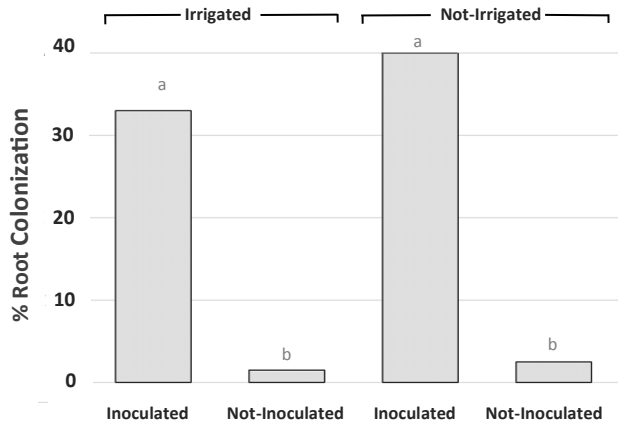
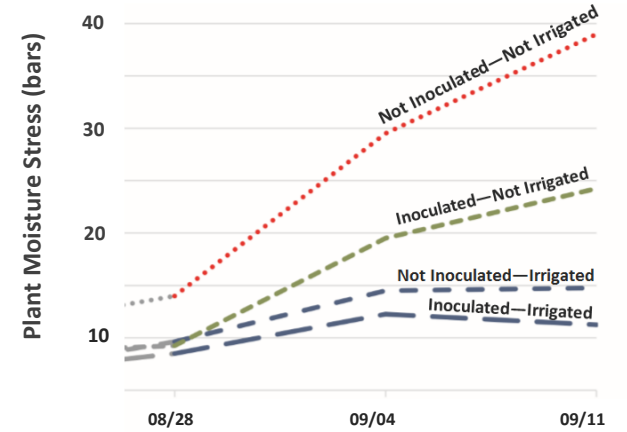
Reference: Brundrett M, Bougher N, Dell B, Grove T, Malajczuk N. 1996. Working with mycorrhizas in forestry and agriculture. Canberra (AU): ACIAR Monograph, 274 p.

Fig 3



Treatments with different letters are significantly different (P<=0.1) by one-way ANOVA

Fig 4



Colored lines are significantly different treatments (*P<=0.1*) by one-way ANOVA.