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Hydrophylic Polymers as a Carrier for VA Mycorrhizal Inoculum[1]

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Abstract

Four techniques of inoculating rooted *Carissa grandiflora* cuttings with the mycorrhizal fungus *Glomus intraradices* were evaluated. Placement of a root inoculum around the root systems of *Carissa* or totally incorporated into potting medium resulted in higher colonization levels than dipping cutting root systems in suspensions of inoculum in Viterra or Terrasorb hydrophyllic polymers. Growth responses, especially top dry weight, showed little difference among the inoculation techniques. Mycorrhizal mediated growth benefits for the tops were realized for all treatments. Storage of root inoculum for 12 weeks at 4.4 °C (40 °F) had little effect on colonization levels by the fungus in *Carissa* roots.

Index words: *Carissa grandiflora,* natal-plum, *Glomus intraradices,* colonization, nursery production

Introduction

Woody landscape plants are commonly propagated asexually in a sterile medium and grown in containers filled with a soilless medium. Current nursery practices of heavy fertilization and irrigation minimize or eliminate beneficial microorganisms that could potentially reduce financial inputs into production (5). Vesicular-arbuscular mycorrhizal (VAM) fungi have benefited growth of numerous plant species in soil of low fertility (7) and container grown woody plants (2,8).

A frequently used technique for inoculating woody cuttings is the placement of a mixtures of chlamydospores, hyphae and fungal colonized root pieces around the host plant root system at the time of potting (2,6,8). High levels of colonization, beneficial growth responses and reduced interference from undesirable competitive soil microorganisms have also been achieved utilizing only colonized root pieces around roots of host plants (8). However, both of these techniques require measuring amounts of inoculum and an additional step in potting.

Granulated hydrophilic polymers upon hydration hold many times their dry weight in water (10). When incorporated in growth media, such polymers increase water holding capacity, drainage and aeration. These materials have also been utilized to protect seeds (4) and root systems (1) from desiccation. Nemec (8) successfully used hydrogels as a carrier for mycorrhizal inoculum in fluid drilling and root-dip experiments.

Objectives of this experiment were to evaluate inoculation techniques utilizing fresh and stored infected root pieces on colonization and growth response of *Carissa grandiflora.*

Materials and Methods

Two groups of rooted cuttings of natal plum [*Carissa grandiflora* (E.H. Mey.) A.D.C.] were transplanted into 800cc (49 in^3) containers filled with Canadian peat moss:fired montmorillonite clay (4:1 v/v) medium. The medium was amended with superphosphate (8.7% phosphorus) and STEM (Soluble Trace Element Mix) at 0.25 kg/m^3 (6.7 oz/yd^3). The mycorrhizal fungus *Glomus intraradices* Schenck & Smith was grown on the roots of containerized bahia grass. The infected roots were washed and chopped into 1 cm (0.4 in) segments for use in subsequent experiments. The first group of rooted *Carissa* cuttings were inoculated at the time of transplanting (time 1) with 0.5 gram (0.02 oz) of the infected root pieces per plant as follows: 1) totally mixed into the container medium; 2) placed directly beneath the cutting root system; 3) root systems dipped into slurries of Terrasorb (a starch hydrolized polyacrylonitrile polymer using potassium hydroxide manufactured by Industrial Services International, Bradenton, FL at 1.5 g/100 ml water); or 4) root systems dipped into slurries of Viterra Plant-gel (comprised of potassium propenoate copolymers manufactured by Nepera Chemical Co., Inc., Harriman, NY, at 1.0 g/100 ml water) containing infected bahia grass root pieces. Half of the inoculum prepared was placed in a covered plastic container and stored at 4.4 °C (40 °F) for 12 weeks. After the storage period, the inoculum was applied to a second group of *Carissa* rooted cuttings in treatments as previously described (time 2). Root pieces of non-VAM bahia plants were applied in treatments as described for VAM plants. Plants were fertilized weekly with 200 ppm nitrogen from 25-0-25 (17.8% NH_4^+, 7.2% NO_3^-, 21.0% K^+).

Plants were grown in a greenhouse with maximum daylight irradiance of 900 $uM\ m^{-2}s^{-1}$ (approx. 9,000 ft-candles) and temperatures maintained at 28 ± 2 °C (82 °F) and 24 ± 2 °C (75 °F) night. A randomized design was used with treatments replicated 12 times and a single plant as the experimental unit.

Growth data and colonization were recorded 5 and 6 months after experiment initiation for the first and second experiment (time 1 and 2), respectively. Root

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colonization by *Glomus intraradices* was determined at termination using clearing and staining procedures described by Phillips and Hayman (9) and a modification of the gridline intersect method (3). Total top and root dry weights were recorded at experiment termination.

Results and Discussion

Colonization of roots was greatest when VAM inoculum was placed around roots of cuttings or completely mixed into the medium for both times (Table 1). Terrasorb and Viterra inoculum slurry resulted in lower colonization levels than the other treatments. Although the same levels of infected root pieces were applied, the amount of slurry-roots that ultimately adhered to the cutting roots was less than the two more conventional systems of inoculation. In addition, the high pH (8.0-10.1) of the gels could have been inhibitive to colonization of *Carissa* roots. Nemec (8) found positive growth benefits to citrus using mycorrhizal soil inoculum suspended in hydrophylic gels. However, many of the results from his experiments were erratic and attributed to variations of pH of the gels. Storage of inoculum for 12 weeks had no impact on levels of colonization in the second experiment (time 2). Tommerup (12) found infected root pieces could be stored at 25 °C (77 °F) for 8 months without reduction of infectivity of inoculum.

Top dry weight at time 1 was improved by inoculation with VAM fungi as compared to non-VAM plants regardless of percent colonization (Table 1). Plenchette (11) similarly noted absence of correlation between percent root colonization and VAM mediated growth response in strawberry. Comparison of treatments for both VAM and non-VAM plants showed no significant differences in top dry weights, except less growth for the Viterra VAM treatment.

Top dry weights at time 2 for complete incorporation and placement of inoculum around host plant roots (treatments 1 and 2) were higher with VAM inoculation, but there were no growth benefits associated with the VAM slurry treatments (treatments 3 and 4) compared to non-VAM plants. Storage of infected root pieces in the high pH gel suspensions may have reduced efficacy of the VAM symbiont. There were not growth differences between the various treatments for VAM and non-VAM plant groups at time 2.

Dry weight of roots was greater for VAM plants only in association with treatment 1 and time 1, while the highest root dry weights at time 2 were for VAM plants and treatment 2. Root growth response in relation to the 4 treatments for either time was highly variable.

Significance to the Nursery Industry

These data substantiate other research that VA mycorrhizal fungi confer beneficial growth response to containerized woody nursery crops. Inoculation of *Carissa grandiflora* rooted cuttings improved subsequent top growth at moderate nitrogen-potassium and low phosphorus fertilization levels.

Suspensions of colonized root propagules in Viterra or Terrasorb gels appear to offer a convenient technique for inoculating rooted cuttings. However, high pH levels of these materials appear to inhibit host root colonization and would require adjustment (pH 5.5-6.0) before the most effective impact could be realized.

The root propagule inoculum can be stored in a cool moist environment for a period of at least 3 and possibly 6 months without loss in efficacy. Hence, inoculum could be readily retained in a "viable" condition over a normal potting period.

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Table 1. Comparison of inoculation techniques with vesicular-arbuscular mycorrhizal fungi on colonization and growth on containerized *Carissa grandiflora* plants.

	Dry Wt Tops (g)				Dry Wt Roots (g)				Colonization (%)	
	Time[x]				Time				Time	
	1		2		1		2		1	2
Inoc. Trt.[y]	myco +	myco -	myco +	myco -	myco +	myco -	myco +	myco -	+	+
1	*5.60 a[z]	3.12 a	*7.08 a	4.90 a	*1.87 a	1.05 a	3.00 a	3.07 a	89.0 a	83.6 a
2	*5.33 a	4.12 a	*6.55 a	4.53 a	1.73 a	1.63 a	*6.70 a	3.28 a	85.8 a	88.7 a
3	*4.85 ab	4.01 a	6.73 a	6.02 a	1.77 a	1.78 a	2.89 a	5.43 a	35.8 b	34.3 b
4	*4.33 b	3.42 a	7.20 a	5.47 a	1.67 a	1.50 a	5.37 a	2.46 a	15.2 c	21.5 c

[x]Cuttings inoculated the day of inoclum preparation (Time 1) or inoculated after 12 weeks storage of inoculum (Time 2).

[y]Inoculation treatments using 1 g portions of infected root pieces as follows: 1) totally mixed into medium, 2) placed directly beneath *Carissa* root system or root systems dipped into slurries of 3) Terrasorb or 4) Viterra Plant-gel.

[z]Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

*Difference between + myco and -myco significantly different at 5% level.

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Response of *Podocarpus macrophyllus* to Rock Phosphate and Mycorrhizae[1]

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Abstract

Shoot and root dry weights of greenhouse-grown mycorrhizal and nonmycorrhizal *Podocarpus macrophyllus* were not different after 8 months. Shoot dry weights were not different for plants grown in the 2 pine bark: 1 moss peat: 1 sand (v/v/v) medium amended with Florida rock phosphate (14% P) at either 0.54, 1.08, 2.16, 4.32, or 8.64 mg P/cm^3 (14.5, 29, 58, 116, or 232 oz P/yd^3, respectively) of medium (2300 cm^3/container) or 0.27 mg P/cm^3 (7.25 oz P/yd^3) from superphosphate (9% P). Root dry weights for plants grown without a P amendment were greater than for plants grown with rock phosphate amendments of 0.54 and 1.08 mg P/cm^3. Growing medium extract P levels 51 days after potting and thereafter were 2 ppm or less for the rock phosphate treatments, while P levels for the superphosphate-amended medium decreased from 169 ppm on day 51 to 9 ppm on day 236. Phosphorus accumulated by shoot and root tissues exhibited a similar relationship to shoot and root dry weights.

Index words: *Glomus intraradices,* superphosphate

Introduction

A common nursery practice is to amend soilless container media with 0.27 mg P/cm^3 (7.25 oz P/yd^3) from superphosphate (9% P) based on the premise that P is fixed by the medium and does not leach. However, recent research indicates that superphosphate dissolves rapidly in media containing largely organic components (21) and most soilless media components have low P fixation capacities (9,23), consequently P leaches. Yeager and Barrett (21) determined that more than 50% of a ^{32}P amendment leached in 3 weeks from media composed of varying ratios of pine bark, moss peat, and sand. In view of the fact that P from superphosphate leaches from soilless media, alternative P amendments should be evaluated.

Rock phosphate is less water soluble than superphosphate (2), consequently P should not leach as readily from rock phosphate-amended soilless media. Powell *et al.* (16) found that mycorrhizal fungi increased P uptake from a rock phosphate-amended soil and increased dry matter production of ryegrass. Other researchers have determined that mycorrhizae facilitate P absorption (4,10,11,12), particularly in growth media with low P availability (10,11,13). The purpose of this research was to determine the growth response of mycorrhizal and nonmycorrhizal *Podocarpus macrophyllus* to rock phosphate amendments and compare growth response to rock phosphate amendments with growth response to a superphosphate amendment.

Materials and Methods

A 2 pine bark: 1 moss peat: 1 sand (v/v/v) medium was fumigated with methyl bromide and amended with

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