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BARD

FINAL REPORT

PROJECT NO. I-916-85

Utilization of Vesicular-Arbuscular Mycorrhiza in Crop Production

J.H. Haas, J. Krikun, J.A. Menge

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BARD project No. I-0916-85RC

Title

Utilization of vesicular-arbuscular mycorrhiza in crop production

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UTILIZATION OF VESICULAR-ARBUSCULAR MYCORRHIZA IN CROP PRODUCTION

BARD Grant No. I-0916-85RC -- FINAL REPORT -- 20 August 1990

Jerry H. Haas, John A. Menge and James Krikun

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C. ABSTRACT

Soil treatments and VAMF inoculation were studied in crops of cotton, onion and pepper. Metalaxyl treatments suppressed Pythium-incited disease and encouraged VAMF colonization of roots, especially in nonfumigated soil. Soil solarization also encouraged VAMF colonization and yield. A combination of solarization followed by VAMF inoculation has great potential for use on nonfumigated soil. The importance of effective VAMF species, availability of young susceptible roots for VAMF infection, and the proper placement of VAMF inoculum in relation to the seed was confirmed; the placement studies were done in fumigated and nonfumigated soil in field plots with cotton and onion.

The response of celery, melon, onion and pepper to VAMF and P fertilization was investigated in field plots in a high P-sorbing loessial soil. Where VAMF were absent, even the highest P level was not sufficient for maximum yields. Melon did not evidence potential for benefits by VAMF augmentation as a horticultural practice. Transplanted pepper growing in a Typic Torriorthents soil had greater total crop yield and a higher percent of that yield with large-size fruits when VAMF inoculation and P fertilization were practiced; fertilized P alone was not sufficient for maximum yields.

A study was completed of the VAMF species present in avocado orchards in Israel and California. There were significant differences in the species present and in the soil chemical and physical characteristics, despite the similarities in climate in the two growing areas. The data obtained will be important for studies of VAMF supplementation in avocado nurseries.

D. PROPOSAL OBJECTIVES

We proposed to continue research initiated in BARD grant no. I-0169-80 which was on the same general subject. In the present project the emphasis was to be on field trials to determine whether mycorrhizal augmentation or encouragement has a commercially-viable potential.

This objective was to be achieved by:

1. Conducting trials on vesicular-arbuscular mycorrhizal fungus (VAMF) supplementation in plots with and without soil treatment which reduce viable VAMF populations in soil.
2. Investigate crops other than citrus and pepper which were the principle crops studied, respectively, by the California (CA) and Israel (IL) groups in the previous BARD-supported project.
3. Testing interaction effects of VAMF with other horticultural practices.

E. REPORT

Almost all of the research which was conducted during the period of the grant has been submitted, accepted, or is in press or published. The manuscripts or reprints are an integral part of this section of the report.

In CA, the effects of soil treatments and VAMF inoculation were studied in crops of cotton, onion and pepper. Metalaxyl treatments suppressed Pythium-incited disease and encouraged VAMF colonization of roots, especially in nonfumigated soil (Afek et al., 1990). Soil solarization also encouraged VAMF colonization and yield. A combination of solarization followed by VAMF

inoculation has great potential for use on nonfumigated soil (Afek et al., 1991a). The importance of effective VAMF species, availability of young susceptible roots for VAMF infection, and the proper placement of VAMF inoculum in relation to the seed was confirmed with these crops and for three VAMF species (Afek et al., 1991b); the placement studies were done in fumigated and nonfumigated soil in field plots with cotton and onion.

In IL, the response of celery, melon, onion and pepper to VAMF and P fertilization was investigated in field plots in a high P-sorbing loessial soil (Krikun et al., 1990). Where VAMF were absent, even the highest P level (25 mg bicarbonate-extractable P kg⁻¹ soil) was not sufficient for maximum yields with celery, onion and pepper. Melon did not evidence potential for benefits by VAMF augmentation as a horticultural practice. Haas et al. (1991) showed that transplanted pepper growing in a Typic Torriorthents soil type, had greater total crop yield and a higher percent of that yield with large-size fruits when VAMF inoculation and P fertilization were practiced; fertilized P alone was not sufficient for maximum yields.

Haas and Menge (1990) completed a study of the VAMF species present in avocado orchards in IL and CA. There were significant differences in the species present and in the soil chemical and physical characteristics, despite the similarities in climate in the two growing areas. The data obtained will be important for continued studies of VAMF supplementation in avocado nurseries.

During a six-mo study visit with D. M. Sylvia, Univ. Florida, Haas participated in the third year of a 3-yr field experiment on the interaction of VAMF inoculation and plant water stress in corn. He collected crop physiology data. The results are being prepared for publication and an abstract of some of the data has been published (Sylvia et al., 1990).

F. COOPERATION

Frequent correspondence and periodic meetings between the principal investigators allowed cooperation in refining plans of the originally-proposed research, in exchanging results and discussions of the grant research and that of other scientists, and in revising particular goals during the period of the grant.

In addition, an Israeli postdoctoral scientist, Dr. Uzi Afek, who had spent some time in the laboratories of Haas and Krikun, was hired by Menge. He also was very active in ensuring close cooperation and communication between the CA and IL groups.

G. ACHIEVEMENTS

The original proposal suggested that "the program will result in

"1) selection of effective strains of VAM-fungi and establish the correlation of colonization rapidity and external mycelium production with strain efficacy;

"2) comparison of the consistent positive growth benefits achieved with inoculation of pepper in fumigated P-sorbing soils, with pepper grown in other arid-land soils;

"3) determination of fertilization practices and inoculum levels required to produce horticulturally acceptable mycorrhizal seedlings of celery, onion, cotton and citrus, for transplanting or as direct seeded plants;

"4) evaluation of the growth and yield effects attributable to VAM-fungus inoculation under various P-fertilization levels under modern agricultural production practices in fumigated and non-sterile soils; and

"5) evaluate the potential for producing VAM-fungus inoculum in the field rather than containers in greenhouse or other controlled environments."

No attempt was made to achieve results (3) and (5) because the original grant was less than half of the proposed budget.

We have demonstrated that the benefits of VAMF inoculation, which usually are shown in greenhouse trials, can be translated to the field. In the greenhouse it usually is impossible to test marketable-yield responses and the root system of test plants are severely restricted and not comparable to that of field-grown crops.

We have produced immediately useful information on (i) inoculum placement in relation to seed, (ii) utility of mixing inoculum with growth media in the nursery for subsequent transfer to the field along with the seedling transplants, (iii) benefits of soil solarization along with VAMF-population augmentation in nonfumigated soil, (iv) importance of controlling plant pathogens in order to achieve maximum VAMF colonization of crop roots, and (v) the inadequacy of P fertilization in replacing VAMF inoculation in high P-sorbing soil, and the ability of the plants to benefit from simultaneous VAMF-inoculation and P fertigation, in spite of the depression of VAMF colonization by P fertilizers.

H. LIST OF PUBLICATIONS

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- Sylvia D M, Hammond L C, Bennett J M, Haas J H. 1990. Field response of corn to water management and inoculation with Glomus etunicatum. (Abstract). Proc. Eighth North American Conference on Mycorrhizae, Jackson Hole WY.