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Technical Bulletin

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COMMERCIALLY SIGNIFICANT BIOLOGICAL ASPECTS OF SPORES OF ECTOMYCORRHIZAL AND VA MYCORRHIZAL FUNGI

Mycorrhizal fungi all reproduce by means of spores. However, these spores differ dramatically in their size, shape, color, longevity, dormancy, and manner of dissemination. This technical bulletin will consider the major commercially significant differences between spores of ectomycorrhizal fungi and VA Mycorrhizal fungi.

Ectomycorrhizal Fungi Spores: Natural Design and Function

Most ectomycorrhizal fungi are basidiomycetes that produce fruiting bodies that sprout above ground to disseminate their spores. Both mushrooms and puffballs belong in this category. Spores produced above ground will be exposed to wind, weather, and sunlight. Those spores that are windborne particularly need a means to withstand the harsh effects of sunlight. Ectomycorrhizal fungi spores that are windborne share several important characteristics:

1. They are much smaller than VAM fungi spores,
2. Most have spines or other surface features to give them lift in the wind,
3. Most are pigmented, and
4. Most are very dry.

Examples include spores of the puffballs *Pisolithus tinctorius* and *Scleroderma* spp. These spores are dark brown or black, and float through the air often over long distances before reaching the ground, where they can be washed into the root zone. Their small size gives them the ability to float in the air over long distances and trickle down through small soil spaces. Their long spines and dark pigments absorb the harmful rays of the sun, thereby protecting the spore. Their dryness belies their deep dormancy and lasting shelf life. Spores of *Pisolithus tinctorius* have retained their infectivity even after 15 years of cold, dry storage.

VA Endomycorrhizal Fungi (VAM) : Spores Natural Design and Function

VAM fungi are members of lower forms of fungi called Zygomycetes. They reproduce either vegetatively via hyphae, or by means of spores produced underground at the ends of specialized hyphal strands growing from plant roots. VAM fungi spores spend their entire life underground, and are not exposed to the wind, weather or sunlight. VAM fungi spores have several notable characteristics:

1. They are large, and are typically packed with carbon nutrition in the form of oil droplets,
2. They are smooth and have no distinct surface characteristics,
3. They have no pigments,
4. They are sensitive to extreme desiccation for long periods.

The large size, weight, and smooth surface of VAM fungi spores makes them unfit for routine windborne dispersal. They can be blown, however, in major dust storms. Their lack of protective pigments renders them unprotected against the damaging rays of the sun. There has been considerable discussion in the industry regarding whether VAM fungi spores and other propagules can be applied to the soil surface and subsequently washed into the root zone. Technical Bulletin No. 2 demonstrated the futility of trying to move VAM fungi spores down through the soil via irrigation.

Effect of Sunlight on VAM Fungi Spore Infectivity

Since VAM fungi spores are not pigmented, and spend their entire life cycle below ground, Plant Health Care, Inc. performed the following tests to determine the degree of sensitivity of VAM fungi spores to natural sunlight.

Test Procedure:

Approximately 18,000 spores of our 4-species VAM cocktail were suspended in 4-ml of water. One ml (4500 spores) was transferred to each of 4 "boats" made of filter paper. Each "boat" was placed inside a covered petri dish. The first dish (A) was covered with aluminum foil to block out all light. Then all four petri dishes were exposed to direct sunlight. After 15 minutes, one petri dish (B) was wrapped with foil. After 1-hour, another dish (C) was covered with foil. After 2 hours (D), the dishes were removed from the sunlight. The spores from all four treatments were washed into individual beakers with about 20-ml of tap water. Each beaker was used to inoculate the roots of separate 3-day-old, pregerminated sweet corn seedlings (3-ml per seedling, 6 seedlings per treatment). One week later, the seedlings were transferred to 1-liter cups containing a sand-based medium. Four weeks later, the root samples were cleared, stained, and assessed for the degree of VAM colonization.

Test Results:

		Percent Colonization of Six Replicates						
Treatment	Exposure Time	1	2	3	4	5	6	Avg.
A	0	70	78	75	68	54	72	70
B	15 min	54	50	45	37	52	68	51
C	1 Hour	33	27	18	39	23	20	27
D	2 Hours	20	<10	<10	<10	14	25	15

Conclusion*:*

Sun light was detrimental to VAM fungi spores, having a cumulatively negative effect on spore viability with increased exposure times. This further complicates attempts to inoculate via surface application. The sensitivity of VAM fungi spores to sunlight is not surprising, considering the fact that these spores develop entirely below ground, develop no protective pigments, and never see the light of day under natural conditions.

What About Artificial Light?

The above test results indicate that natural sunlight is detrimental to VAM fungi spore viability. However, does artificial fluorescent light have a similar effect? Plant Health Care, Inc. performed tests to determine the degree of sensitivity of VAM fungi spores to fluorescent light. The results appear on the following pages.

Effect of Fluorescent Light on VAM Fungi Spore Infectivity

Plant Health Care, Inc. performed the following test to determine the degree of sensitivity of VAM fungi spores to artificial fluorescent light.

Test Procedure:

Three grams of VAM fungi spores (3412 spores/g) were placed in each of 8 dry glass test tubes. Four of these tubes were wrapped with aluminum foil to block out the light. All 8 tubes were held for 2 days in the lab under ambient lighting. An amount containing 300 spores (0.088 g) was removed from each test tube and inoculated onto roots of pregerminated sweet corn seedlings. After 38 days, the roots were harvested, cleared and stained for degree of mycorrhizal colonization. Results appear below:

Test Results:

Percent Colonization of Corn Roots by VAM Fungi Spores With and Without 2-Day Exposure to Fluorescent Light

	Percent Colonization of Four Replicates				
Treatment	**1**	**2**	**3**	**4**	**Avg.**
Dark	38	34	33	62	42
Fluorescent Light	46	53	65	38	51

Conclusion:

Results indicate that ambient room fluorescent lighting had no detrimental effect on VAM fungi spore infectivity after 2-days exposure.

Reports in the Literature

There are other reports in the scientific literature for both spores and non-spore propagules, indicating some degree of detrimental effect for sunlight and also for fluorescent light. (See references.)

Schenck, N.C., S. O. Graham, and N. E. Green. 1975. Temperature and light effects on contamination and spore germination of VAM fungi. Mycologia LXVII (6): 1189-1192.

Varela-Castejon, C. et al. 1998. Fluorescent light inhibits the germination of propagules of the AM fungus *Glomus macrocarpum*. Soil Biol. Biochem. 30(13): 1845-1847.