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Technical Bulletin

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Mycorrhizal Fungi Can Reduce the Effects of Drought on Plants

VAM fungi colonize the roots of host plants and perform absorption services for the plant. Various studies have demonstrated that plants associated with VAM fungi show increased uptake of various materials from the soil, including water, and macro and micronutrients compared to non-VAM plants. As a result, VAM fungi improve their host plants' ability to grow under conditions of drought stress or in mineral deficient soils.

Drought Stress

One of the major limiting factors for plant growth is water availability. Drought affects many aspects of plant physiology and tends to shut down plant growth and reduce photosynthesis. This impacts the flow of sugars from the host plant to its fungal partner. Therefore, VAM fungi have a vested interest in reducing drought stress for their host plants.

How VAM Fungi Address Drought Stress

VAM fungi actively reduce drought stress symptoms in their host plants. Research has shown various ways this is accomplished. These are:

1. VAM fungi expand the roots by adding their own expansive network of absorbing strands to mine the soil for water and the dissolved minerals carried therein.
2. VAM fungi affect the opening or closure of the breathing pores in leaves. These pores are called "stomates." Under conditions of drought stress, the plant will close the stomates to reduce water loss. VAM fungi can affect the closure of these pores and help provide more efficient water conservation.
3. VAM fungi increase water pressure (turgor) in plant tissue (via 1 and 2 above), thereby preventing or delaying wilting. This supports cell function, allowing growth and photosynthesis to continue.

As a result of these effects, under conditions of drought stress, plants that are associated with VAM fungi outperform non-VAM plants in regard to growth, mineral content in tissues, reduced or delayed wilting, and overall metabolism.

Implications for Agriculture

In areas where agriculture is practiced without regular irrigation, VAM fungi can have a dramatic impact on crop yield. VAM fungi can significantly increase plant growth and crop yield in areas where regular irrigation is impossible, impractical, or too costly.

Limitations of VAM Use in Agriculture

The principal limitation is cost. While inoculants containing VAM fungi are available, their cost needs to be compared to the overall value of the crop. In many cases, the cost of inoculation is too high compared to the crop's value. In such cases, one may still be able to activate naturally-occurring, native VAM fungi that are already in the soil.

Alternatives to Soil Inoculation

In situations where direct application of VAM fungi is too costly or not practical, you can harness the services of the native VAM fungi already in the soil by applying a stimulant that can increase the level of root colonization by these fungi. Certain root extracts have been shown to have such an effect. Among these is a plant extract called “formononetin.” Formononetin is naturally-occurring in a wide range of plants including clover and soy bean. Application of formononetin to soils containing VAM fungi produces an increase in the physical connection between VAM fungi and their host plants. In the presence of formononetin, VAM fungi will produce significantly more points of contact and penetration into host root tissue. This often results in increased crop yield, and this effect is more dramatic under harsh environmental conditions, particularly drought stress and reduced soil fertility. Of course, use of such stimulants is only effective in soils that already contain some VAM fungi. Fumigated fields would be devoid of live organisms, and therefore, would not respond to such a treatment.

Commercially-Available VAM Stimulant

Extraction of formononetin directly from plants is costly and very inefficient. Fortunately, scientists have devised methods for manufacturing formononetin from commercially-available substances using a patented process. As a result, formononetin can be mass-produced efficiently and at a much lower cost compared to direct plant extraction.

Vamtech, LLC, a subsidiary of Plant Health Care, Inc., is the sole manufacturer of formononetin by this patented process. Vamtech produces formononetin in three product formulations where it is the major ingredient. These products are all labeled under the brand name “Myconate®”. Each formulation is designed for a different application, including seed coating, water suspension, and dry application.

Plant Health Care, Inc. uses formononetin as an important ingredient in its various mycorrhizal inoculant products, and features formononetin as a principal active ingredient in its Colonize® brand of products. These include Colonize® T&O for use with turf and ornamental plants, and PHC Colonize® AG, for use in agriculture. In addition to formononetin, these latter 2 products also contain PHC’s proprietary bacteria blend. These bacteria can fix nitrogen and solubilize mineral phosphates, thereby providing a degree of slow and sustainable biofertility.

Summary

Mycorrhizal fungi can significantly increase water uptake by their host plants, and can provide a measurable degree of drought stress for plants grown under droughty conditions where irrigation is not available. Fields without irrigation can produce increased crop yields by applying mycorrhizal fungi inoculants, or by stimulating root colonization of native VAM fungi. The latter method tends to be less costly, and therefore, has more application in agriculture.

Aside from reducing water stress, mycorrhizal fungi also improve mineral absorption. As a result, VAM fungi can also produce increased or sustained yields with reduced fertilizer application. This can reduce farm expenses and cut down on pollution of surface and ground water. The magnitude of these effects varies with different crops and different farm practices.

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