**Comparison of indigenous microorganism and commercial soil inoculant on crop yields & basil downy mildew disease resistance.**

At a time of increasing demand for sustainably grown crops, farmers in the Northeast face numerous challenges, including drought and the emergence of new diseases. There has been a growing interest in the role of soil microorganisms, and more specifically fungal inoculant, as they hold the promise of offering economic and environmental benefits. Peer reviewed research has shown that healthy population of soil microorganisms have the potential to provide tangible benefits to farmers including: crop yield, disease resistance, improved release and transport of nutrients, production of soil stabilizing humic compounds and improved abiotic stress tolerance. One part of the soil biome of particular interest are mycorrhizal fungi. Mycorrhizal symbiosis is arguably the most important symbiosis on earth, yet current mainstream agricultural methods deplete native mycorrhizal species and disrupt related ecological cycles. Research shows using fungal inoculants can help improve plant nutritional value, improve disease resistance, decrease soil erosion, decrease pesticide and artificial fertilizer inputs, improve soil quality and improve production under abiotic stressors such as drought. However, much work remains to demonstrate how to best utilize soil microorganisms to best achieve these results, especially on smaller polyculture farms common to the Northeast.

In order to further explore two aspects of the tangible benefits of promoting soil microorganisms and inoculating with mycorrhizal fungi, a research project was designed to look at the crop yield of five marketable crops [Sweet Basil (*Ocimum basilicum),* Ashwagandha (*Withania somnifera)*, Parsley (*Petroselinum crispum)*, Fennel (*Foeniculum vulgare),* and Onion (*Allium cepa)*] under three treatment conditions at the time of seedling transplantation: untreated control seedlings, seedlings treated with commercial mycorrhizal inoculant and seedlings treated with a simplified on-farm produced IMO (indigenous microorganism) inoculant. In addition to measuring crop yields, a similar treatment design was also used to measure resistance to downy mildew disease in sweet basil. Basil Downy Mildew was chosen because it is a devastating oomycete (*Peronospora belbahrii)* that can cause 100% crop loss; there are currently no effective organic or conventional controls. Basil is the most econonomically profitable annual culinary herb crop in the United States, and crop losses due to Basil Downy Mildew can have a significant negative economic impact on vegetable and herb growers.

This research project was completed on a small medicinal and culinary herb farm in Northwest CT, Pleasant Valley Botanicals, in the summer of 2017. The research was completed by the farmer and volunteers, with statistical analysis by Dr Maura Bozeman (a professor of Environmental Sciences at Post University in CT), and with funding by the Northeast SARE program (Sustainable Agriculture Research and Education). This author would also especially acknowledge the assistance and formative research of Joan Allen (UCONN Assistant Extension Educator), who died suddenly in 2018.

This research used a block design method, where each of the five crops in the field received one of three treatments at time of transplantation: a control, a commercially purchased fungal inoculant, and a homegrown fungal inoculant called IMO (Indigenous Microorganism). IMO inoculant is based on a Korean Natural Farming method, designed to cultivate a native population of mycorrhizal fungi and hopefully provide a wide range of benefits to the plants through these symbiotic relationships. IMO is a method of fungal inoculation of interest to many farmers because of the benefits as well as on farm production method.

As each crop was harvested throughout the growing season, the yield was recorded from plants in each of the different treatments; crops were then included in the farm’s Medicinal Herb Community Support Agriculature (CSA) shares. After data analysis, no crops in the IMO or commercial inoculant treatments had statistically significant improvements in crop yield compared to the control treatment. We also looked at the total inter-species crop yield from each bed, to see if there was any possible benefit from the common mycorrhizal network. The CMN concept has shown that fungi will share nutrients between different species of plants, such as one study showing nutrient flow between a Douglas Fir, a Paper Birch and a Western Red Cedar. However, there was also no statistically significant increase in inter-species crop yield.

Ultimately, this researcher concluded the environment created in the field trial did not meet the conditions necessary to support the mycorrhizal fungi and ultimately the benefits to crops as measured by yield. Regenerative agriculture theory presents us with three key components to have more effective sustainable agriculture systems: cover cropping, crop diversity and low or no-till practices, all of which have numerous benefits including the promotion of soil life. This particular field design only incorporated crop diversity, as there was no prior cover cropping and the design method incorporated significant prior soil disturbance. Other research strongly suggests that maximum benefits are achieved by the inoculation of plants at the time of seeding (germination) as opposed to at the time of transplantation, as done in this study. It is also very important to acknowledge that these findings are set within the specific conditions of one farm in one season, with numerous situational, geographic and weather related influences. Just one example would be the potential impact of precipitation in the month of July; July is historically the driest month in Connecticut but according to NOAA data, in July 2017, Connecticut had twice the monthly average rainfall. There is strong evidence from prior peer-reviewed research that the benefits of mycorrhizal symbiosis may be most prominent during mild to moderate drought conditions, the opposite of what this growing season presented.

For the concurrent research on disease resistance, additional Sweet Basil plants in each treatment protocol were monitored weekly for signs of Basil Downy Mildew based on percentage of leaf area with sporulation. There was a delay in infection in Basil plants inoculated with the Indigenous Microorganisms treatment (please see graph), which is a potentially promising finding worth further investigation. Even more exciting were two Basil plants in the IMO treatment protocol that were infected with Basil Downy Mildew (which typically has 100% crop loss), but then made a significant recovery with new healthy leaf growth. This finding may be an indication of systemic acquired resistance, though such a conclusion is beyond the scope of this study. This resistance is when a plant is able to develop an immune response or resistance after exposure to a pathogen, in this case because of the benefits of mycorrhizal symbiosis. Plants growing as part of a healthy ecosystem that includes mycorrhizal fungi have improved access to the diversity of metabolites and are better equipped to combat pathogens. Remarkably, plants can down-grade their immune systems to allow for beneficial symbiotic relationships, which later can protect them from other pathogens.

Setting this research project within a larger body of knowledge, the author would offer the following conclusions to gardeners and polyculture farmers: By adding fungal inoculants at the time of seeding, we improve the likelihood of seeing beneficial results. By exploring low cost, low tech methods of cultivating local indigenous microorganism, we may find benefits well worth the effort. But most important is supporting growing conditions where soil microorganism can thrive, which can potentially help grow higher quality plants and produce increased crop yield, and offers significant environmental benefits. If used simultaneously, the three key tenets of regenerative agriculture: use of cover crops, crop diversity and low or no-till practices, potentially will create a habitat for the soil microorganisms and their associated benefits. In additional, these practices bring us back to farming methods more in keeping with natural processes than current conventional agriculture methods.

Melody Wright is the farmer/founder of Pleasant Valley Botanicals, a small farmlet growing vibrant medicinal and culinary herbs for the local community. Her commitment to growing medicinal herbs is based in her belief of herbs as an integral part of affordable and holistic health care and agricultural systems.

The author welcomes correspondence on this article, and will gladly share the data and findings, a bibliography of helpful books and relevant peer-reviewed research, or information about the SARE program for interested medicinal herb farmers. Pleasantvalleybotanicals@gmail.com or pleasantvalleybotanicals.com

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