Can Mushroom Production Help Your Soil and Vegetable Production?

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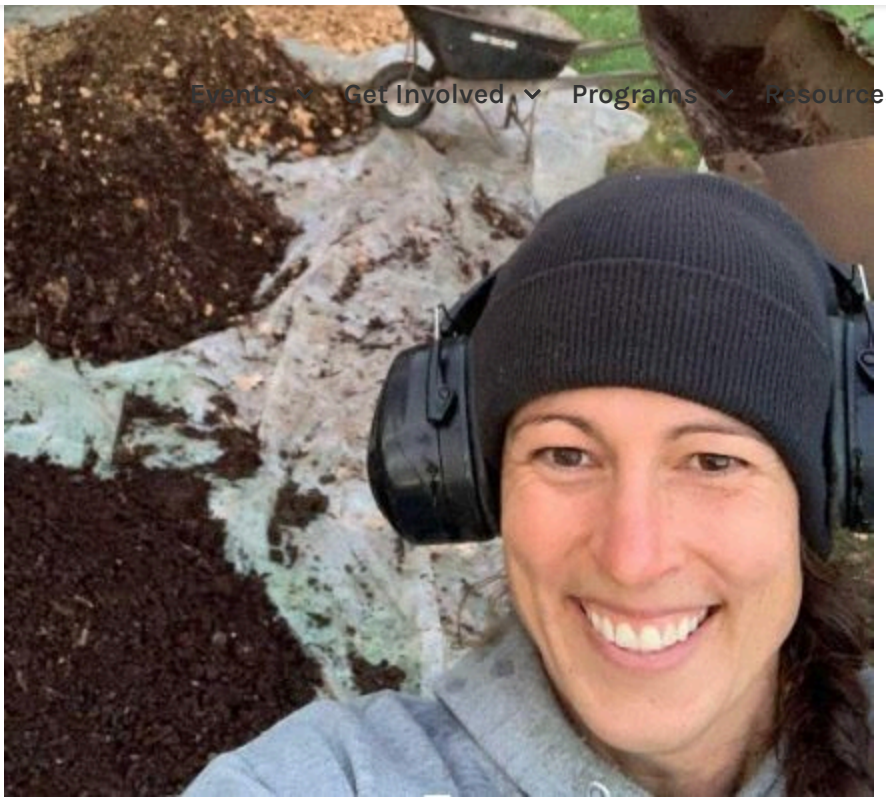
By: Christine Manuck, NOFA/Mass Assistant Development Director

Soil health and proper soil management is essential to organic farming and gardening, and at NOFA/Mass we are routinely trying to find ways to help farmers and gardeners improve the health and productivity of their soils. Rubén Parrilla, NOFA/Mass Technical Assistance Program Director, has spent the past several years looking deep into soil to observe the biology, or, more specifically, the *micro* biology, of what's in there, to help growers improve their production. The microbiology of soils differs from the earthworms, insects, and roots that you see when you're farming or gardening: a soil's *micro*biology is all of the microscopic bacteria and fungi that regulate what goes on in the soil, such as making nutrients available for plant uptake and controlling the acidity of the area around plant roots. [A side note, however, as not all fungi are microscopic! Some can get really big (such as mushrooms!), and some fungi, such as mycorrhizae, can form connective networks under your soil to help plants take up phosphorus, nutrients, and water. Thus these not always microscopic soil dwellers are pretty important!]

After spending so much time looking at soil and microbes, Rubén's relentlessly curious mind has been trying to find new ways to improve the microbiology of farms and gardens. It's no secret that



Ruben and Brittany Overshiner of Upswing Farm mix together the SMS and compost amendment piles

when mixing up a liquid fertilizer, you need to have the right ratio of one thing to another for it to work properly. Having the ideal ratio of fungi to bacteria in your soil helps optimize it to improve your soil health and production.

Fungi play major roles in regulating soil fertility, improving soil structure, and controlling soil-borne diseases. They decompose organic materials into smaller particles that can be used by other soil organisms, including plant roots, and help develop soil humus and aggregates, which are essential to healthy soils. Understanding the relationship between fungi and bacteria, and the quantities of each, can help growers regulate the microbe-driven practices occurring within their soils.

Following from some creative, “outside the box” thinking, NOFA/Mass is now in the middle of an 18-month project funded by Northeast Sustainable Agriculture Research and Education (SARE) to evaluate the effects of combining spent mushroom substrate (SMS) – the woody byproduct of mushroom farming that is teeming with fungal spores – with *mature* compost. Mature compost is used because the heating process that occurs during compost development has the potential to kill many of the fungi the SMS would introduce, which also explains why typical compost is so low in fungi to begin with. The goal of this project is to determine whether, when mixed, the fungi in SMS could inoculate the mature compost to create an amendment richer in fungi and with a more ideal ratio of fungi to bacteria than just typical compost.

Mushrooms are considered to be one of the most environmentally-friendly foods to produce, and recent increased consumer demand for specialty mushrooms has led to increased production

NOFA/Mass have been evaluating the practical potential for SMS as a carbon-rich soil amendment, particularly in combination with the bacteria-rich compost that farmers are already applying since August 2022.

The goals of this project are to determine whether finished compost can be inoculated by SMS over a 14-day duration, and whether the resultant amendment causes any change in soil physical and biological properties following application in a manner typically used by small-scale vegetable growers. Rubén spent fall 2022 delivering SMS to five project farmers throughout Massachusetts, guiding them on evaluation techniques throughout the 14-day inoculation period. To inoculate the compost with SMS, Rubén and the farmers mixed the compost with the SMS at three different rates to observe the changes in compost at each rate. The farmers monitored the amendment piles every other day for 14 days, evaluating for moisture, temperature, and visible changes to the mixtures. The piles were covered with tarps, with a goal of keeping the piles moist but not excessively wet, and watered as needed to achieve these conditions.

Variations in the SMS-Compost amendment piles after the 14 day inoculation period. Number on the bottom left of each paper refers to the percent SMS in each sample (10 = 10%, 25 = 25%, etc.)

When the amendment was ready to be applied, Rubén took baseline soil health measurements, including a microbiological analysis, so we could monitor soil changes in response to the SMS-compost amendment application. The amendment was applied by farmers to their production beds that fall, and Rubén will return to the farms to perform repeat soil microbiological assessments in spring 2023 and fall 2023.

Compost mixture resulted in an average fungi to bacteria ratio of 0.5:1 – right in the middle of the targeted range. In contrast, microbiological analysis of the compost farmers provided as a part of this project (which is the same compost they were using for their typical management), showed the average fungal to bacterial ratio to be 0.03:1, significantly below the recommended range.

These fungi to bacteria ratio findings are also supported by observations of total fungi and total bacteria: total fungi were greatest in the mixtures with the greatest amount of SMS, and lowest in the mixtures with the smallest amount of SMS. Along these lines, total bacteria were lowest in the mixtures with the greatest amount of SMS and highest in the mixtures with the smallest amount of SMS. Interestingly, the total number of bacteria between the three trial mixtures (10% SMS, 25% SMS, and 50% SMS) were fairly similar, suggesting that the changes in the fungi to bacteria ratio were more a function of an increase in fungi than a decrease in bacteria.

Inoculating compost with SMS also led to a proportional increase in beneficial nematodes, with the 50% SMS/50% compost mixture revealing a whopping 4800 nematodes per gram, compared with the 10% SMS/90% compost amendment at 670 nematodes per gram, and unamended compost with 120 nematodes per gram. The total number of beneficial Protozoa were also evaluated, yet the results were somewhat inconclusive: the number of beneficial protozoa were greater in the amendments with SMS than only compost, yet the 10% and 25% SMS amendments had more protozoa than the 50% SMS amendments, suggesting that there may be other factors regulating the beneficial protozoa populations. The amendment development will be repeated this spring, giving us additional data to help understand these findings.

Moving ahead, Rubén, NOFA/Mass, and the project farmers are eager to continue this work throughout the remainder of 2023 to further our understanding of the impacts of inoculating SMS with compost and applying it to production beds. We look forward to sharing additional information on the project through another newsletter article this fall that will summarize an additional 6 months' worth of project findings. Upon conclusion of the project, findings will be summarized and reported to SARE, and made available directly through both NOFA/Mass and SARE.

You can learn more about the project at our upcoming event at Fat Moon Farm on Tuesday, March 21st. The event at Fat Moon Farm will provide an immersive mushroom production learning opportunity, where participants will be able to talk to the mushroom farmers and learn about their production and practice. Rubén will also be on hand to discuss this project, uses of SMS, and strategies for farmers to improve their soil microbiology. He'll also have a microscope handy to

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