

How Does the Addition of Mycorrhizae Affect the Growth of Basil, Tomatoes, and Beans in a 50% soil and 50% martial stimulant potting mix?

BACKGROUND

The team decided to conduct an experiment on mycorrhizae affecting growth because even large quantities of microbes are extremely compact and lightweight making them ideal for space transport. Since there is no life on Mars, the team wanted to determine if mycorrhizae would have a significant positive impact on plants that grew in the stimulant. Mycorrhiza is a fungus that facilitates the underground nutrition-gathering process for plants which supports growth. The results of the experiment are valuable because if this minor addition greatly aids in plant growth, it could affect how plants would be grown on Mars and the ability for humans to live in that environment long term.

EXPERIMENT DESIGN

There were a total of 12 plants grown in this experiment, 4 of each type of plant grown. The team used three types of plants to see how mycorrhizae affected various plants. The three plant types were Bush Blue Lake 274 Bean, Baxters Bush Cherry Tomato, and Genovese Basil. Bean plants are a simple, easy to grow plant, tomato plants usually need more nutrients and produce large fruit, and basil plants are used for their leaves instead of their fruit. The specific varieties were chosen since they should reach maturity during the test period. Two of the plants' pots were controls, one with mycorrhizae and one without, that consisted of only potting soil. This method was used so the team could compare the effect of mycorrhizae on martial stimulant compared to regular earth soil. The other two pots contained a mixture of 50% martial stimulant and 50% commercial potting mix; one of those pots had additional mycorrhizae, and the other didn't.

The commercial potting mix consisted of 95% sphagnum peat moss, pertile, and a wetting agent. Peat moss is a common ingredient in potting mix because it's a soil amendment that lasts for several years. Pertile is a volcanic glass that is used to improve aeration and modify soil substructure. The wetting agent is utilized to make sure the soil remains fairly compact. The potting mix also contains 0.03% nitrogen, 0.03% phosphate, and 0.03% potash. Nitrogen is very important for plant growth because it helps ensure energy and regulate nutrient uptake. Phosphate plays a major role in mineralization of organic phosphorus in soil, and organic phosphorus is vital for photosynthesis, energy transfer, and nutrient movement. Potash is a source of potassium, which improves the uptake of nitrogen from the soil and the conversion of nitrogen in the plant to amino acids. All of these ingredients aid in plant growth.

When the soil and seeds were all prepared, they were separated into two main groups: pots with mycorrhizae and pots without additional mycorrhizae. The groups were put into different trays for easier watering. The water was different for each group as well; the pots with mycorrhizae were watered with a solution that also contained mycorrhizae. Both groups' water also contained a commercial fertilizer.

The fertilizer consisted of 24% nitrogen, 8% phosphate, and 16% potash. It also contained 0.02% boron, 0.07% copper, 0.15% iron, 0.05% manganese, 0.0005% molybdenum, and 0.06% zinc. Boron is an essential nutrient for development and optimum growth. Copper is an important

metal that aids in photosynthetic and respiratory electron transport chains and cell wall metabolism. Iron is involved in the synthesis of chlorophyll. Manganese is a cofactor for the oxygen-evolving complex of photosynthetic machinery. Molybdenum is a component in two enzymes that convert nitrate into nitrite, and nitrite into ammonia. Zinc is used to activate enzymes that are responsible for the synthesis of certain proteins. The addition of all these ingredients in the fertilizer facilitate plant growth.

The plants were watered with their respective solutions daily. During week 2, all of the plants were brought outside in Cypress, TX, so they could all receive natural sunlight. They were quickly brought back inside on week 3, for the outdoor temperature in Cypress at that time was over 95°F during the day and 80°F at night. These conditions were determined to be too harsh for seedling growth based on the deterioration of the seedlings even with adequate watering. The bean plants even died during their short time outside. After the bean plants were replanted, all of the plants remained inside for the rest of the experiment.

HYPOTHESES

If mycorrhizae is added to half of the plants, then the plants with mycorrhizae will grow taller than the plants without mycorrhizae.

PARAMETERS

Type of plant (Basil, Tomatoes, or Beans) and if mycorrhizae was added

DEPENDENT VARIABLE

Height of plant

MEASUREMENTS

The height of the plant will be measured in cm once a week. Since not enough pH strips were provided, the pH of only the soils with basil were measured.

CONTROLS

All plants were given the same amount of water, light, and were at the same temperature.

RESULTS

There was an obvious difference between the plants grown in Earth soil and plants grown in martial stimulant, with the “Earth plants” growing taller. In general, the addition of mycorrhizae also helped the Earth plants more than the ones with martial stimulant. In other words, there was a larger difference between the height of the Earth plants with and without additional mycorrhizae, than the height of the Mars plants with and without additional mycorrhizae.

The weekly measurements were:

Height of Basil Plants Each Week (cm)

	Basil in Mars Stimulant Without Mycorrhizae	Basil in Mars Stimulant With Mycorrhizae	Basil in Earth Soil Without Mycorrhizae	Basil in Earth Soil With Mycorrhizae

week 1	1.4	1.2	1.0	1.3
week 2	4.5	3.0	7.1	11.7
week 3	4.6	3.6	10.3	12.2
week 4	4	4.1	20.1	20.4
week 5	5.5	4.1	23.3	26.8
week 6	5.7	4.1*	26.7	29.9
week 7	5.8	4.1	30.1	33.8
week 8	5.6	4.1	34.7	38.3
week 9	5.5	4.1	37.0	42.6
week 10	5.5	4.1	39.3	45.4

*the basil plant in mars stimulant with additional mycorrhizae died completely during week 6 and didn't grow

The pH of the soil of the basil plants was also measured. However the results did not show significant variation. The precision of pH strips is +/- 1 so small variations in pH are not detectable. A pH meter may have provided more detailed data allowing further conclusion on this parameter. The pH of all the soils remained around 7.

pH of Basil Plants Each Week

	Basil in Mars Stimulant Without Mycorrhizae	Basil in Mars Stimulant With Mycorrhizae	Basil in Earth Soil Without Mycorrhizae	Basil in Earth Soil With Mycorrhizae
week 1	6	7	7	7
week 2	7	7	6	6
week 3	7	7	6	6
week 4	6	7	7	6
week 5	7	6	7	6
week 6	6	6	7	7
week 7	7	7	7	6
week 8	7	7	7	7
week 9	7	6	6	7
week 10	7	7	7	6

As stated previously, the bean plants died during week 3, so they were replanted to continue the experiment.

Height of Bean Plants Each Week (in cm)

	Bean in Mars Stimulant Without Mycorrhizae	Bean in Mars Stimulant With Mycorrhizae	Bean in Earth Soil Without Mycorrhizae	Bean in Earth Soil With Mycorrhizae
week 1	12.3	9.5	12.1	9.6
week 2	13.0	13.5	13.2	16.4
week 3	0.0*	0.0*	0.0*	0.0*
week 4	2.6	9.0	16.4	13.8
week 5	9.0	9.9	27.9	24.0
week 6	9.2	11.1	31.2	29.4
week 7	8.9	12.2	33.0	34.6
week 8	8.4	14.0	34.3	38.5
week 9	8.2	14.7	34.9	42.2
week 10	8.1	15.1	35.2	46.0

*during week 3, all of the bean plants died and were replanted. They didn't sprout at the time of measuring

An interesting thing to note about the tomato plants is the pots. Due to their size, the tomato seeds were planted into larger clay pots. The pots that contained martial stimulant were coated in a mineral like substance; this was likely due to the higher amounts of mineral in the stimulant seeping out of the clay pot. This didn't happen in the other pots (beans nor basil) because they were in the less porous plastic pots.

Height of Tomato Plants Each Week (in cm)

	Tomato in Mars Stimulant Without Mycorrhizae	Tomato in Mars Stimulant With Mycorrhizae	Tomato in Earth Soil Without Mycorrhizae	Tomato in Earth Soil With Mycorrhizae
week 1	4.1	4.1	5.8	5.5
week 2	5.6	6.5	16.5	17.7
week 3	8.0	12.1	20.7	24.4
week 4	14.4	17.9	35.9	36.1
week 5	24.8	25.1	36.1	37.4
week 6	28.8	28.2	40.0	42.3
week 7	35.6	30.3	44.6	48.4

week 8	42.2	31.6	47.2	53.1
week 9	49.4	35.1	54.2	58.3
week 10	55.6	37.0	56.9	61.4

DISCUSSION & CONCLUSIONS

According to the results, mycorrhizae didn't have a major effect in the plants that grew in a martial stimulant. The only Mars plant with mycorrhizae that grew better than its counterpart was the bean plant. Furthermore, the basil plant in Mars stimulant with mycorrhizae died after week six.

This is contrasted with the Earth plants with additional mycorrhizae, which all outgrew their counterparts by at least 4.5 cm. It was expected that the Earth plants would grow taller than the Mars plants, but it was surprising to see that the mycorrhizae had a different effect on the two potting mixes.

The results imply that little to no resources should be used on shipping mycorrhizae to Mars for planting. Instead, the resources should be used on fertilizers, which seemed to have a more positive effect on plant growth, but that cannot be directly determined from this experiment. Mycorrhizae may be important for commercial farming, but assuming from this experiment, it is not significant for martial planting.

It is apparent that the Earth plants outperformed the Mars plants by a wide margin. The martial stimulant was mixed with only 50% soil, that being the maximum amount allowed by the experiment criteria. More experimenting could be done to find the most efficient ratio of martial stimulant to Earth soil. Furthermore, resources should be invested into finding methods of affordable transport of the Earth soil and other fertilizers to Mars.

For future experiments, a major parameter that could be improved is the amount of seeds planted. The team was limited by the amount of martial stimulant, and an increase in the amount of plants grown would improve the reliability of the results. Another thing that would make the results more reliable is to use a more precise way to measure the pH of the soil. The pH strips were limited to whole numbers, so a device that can measure decimals would provide more accurate results.

PHOTOS



Week 1:



Week 2:



Week 3:





Week 4:



Week 5:





Week 6:



Week 7:



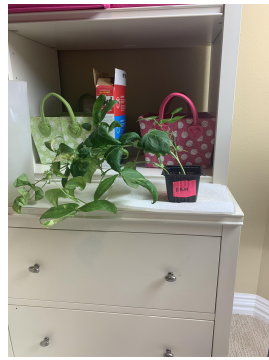
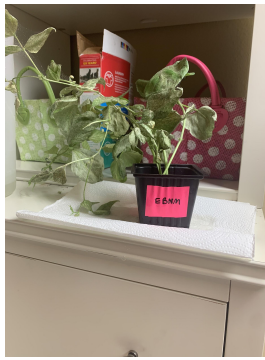


Week 8:



Week 9





Week 10

