THE DIRT ON PH FOR PLANTS

Introduction

Plants rely heavily on bacteria to convert chemicals into nutrients that they can absorb and use to grow. One important example of this is the bacteria which convert ammonium (NH_3) to nitrate (NO_3). The chemical equation for this conversion is shown in the equation below:

$$2NH_3 + 3O_2 + \text{bacteria} \rightarrow 2NO_3 + 6H^+$$

When this conversion happens, the concentration of protons (H^+) in the soil increases. This makes the soil naturally more acidic and lowers its pH.

Since ammonium and nitrate are both necessary for plant growth, products like Liquid Miracle Grow Plant-Food have been developed to increase the amount of both ammonium and nitrate in the soil. Since more ammonium is available in the soil, bacteria can convert more ammonium to nitrate, which results in a higher amount of free protons. Thus, adding Liquid Miracle-Grow to soil will lower the pH of the soil over time, making it more acidic. Lowering the pH can be dangerous to plants and the microorganisms within the soil. If the soil conditions become too acidic, subsequent generations of plants and bacteria may be unable to sustain growth. As soil conditions are already becoming increasingly acidic due to acid rain, one wonders whether the short term benefits of Miracle-Grow are worth the potential long-term damages to the soil.

In this experiment, students will use an electrode to measure the pH of the Liquid Miracle-Gro Plant Food before and after it passes through soil. These values will be compared to the values obtained for regular water before and after it passes through soil.

Procedure

1) Prepare two large funnels by scrunching two pieces of cheesecloth at the base of each one so as to plug it. Stuff cheesecloth as tightly as possible. Label one of the beakers “Miracle-Gro” and the other beaker “Water”. Place a glass beaker (1000mL) beneath each funnel.
2) Use one of the polypropylene beakers (400mL) to scoop out dirt from the potting soil bag. Fill the beaker to the brim. Tap the beaker on the table to ensure the soil settles down into air spaces. Pour one full beaker of soil into each large funnel and lightly pack the soil with seeds.
3) Obtain two polypropylene beakers from the teacher, one filled with 300mL of the Liquid Miracle-Gro solution and one with 300mL distilled water.
4) Using the electrode, record the pH of both solutions. Take three pH readings for each solution and use the average of the three readings as the pH of that solution.
5) Add each solution to the appropriately labeled funnel. When pouring the solution over the solution, pour very slowly and attempt to cover all of the visible soil with solution.
6) After each solution has passed through the soil and has been completely collected in the glass beaker beneath the funnel (i.e., no solution is dripping from the glass funnel) record the pH of the solution that has passed through the soil. Once again, take three measurements and use the average as the pH for that solution.
7) Over the next several weeks, water both plants with 300mL of distilled water every 3-4 days. While watering record any unusual odors or differences between the two plants. After 10 days, add another 300mL of Liquid Miracle-Gro Plant food to the funnel labeled “Miracle-Gro.”

Results

	Avg pH before soil	Avg. pH after soil	Difference Between Averages
Distilled Water			
Liquid Miracle Grow			

Describe any differences between plant growth, or any other differences between the two plants that were observed.

Discussion

1) Compare and contrast the before and after pH for the plain water and the liquid Miracle-Gro.
2) Miracle-Gro contains a substantial amount of ammonium (NH_3). Ammonium is a weak base. How do you think ammonium contributed to the pH measurement of the Liquid Miracle Grow before it was added to the soil?
3) Which seemed to take longer to pass through the soil, the Liquid Miracle-Gro or the distilled water? Why do you think one took longer than the other one?
4) Did one of your plants smell a bit like vinegar? Why do you think that plant would smell like vinegar while you watered it, but the other one did not?

THE DIRT ON PH FOR PLANTS – Teacher Supplement

Introduction

Plants rely heavily on bacteria to convert chemicals into nutrients that they can absorb and use to grow. One important example of this is the bacteria which convert ammonium (NH_3) to nitrate (NO_3). The chemical equation for this conversion is shown in the equation below:

$$2NH_3 + 3O_2 + \text{bacteria} \rightarrow 2NO_3 + 6H^+$$

When this conversion happens, the concentration of protons (H^+) in the soil increases. This makes the soil naturally more acidic and lowers its pH.

Since ammonium and nitrate are both necessary for plant growth, products like Liquid Miracle Grow Plant-Food have been developed to increase the amount of both ammonium and nitrate in the soil. Since more ammonium is available in the soil, bacteria can convert more ammonium to nitrate, which results in a higher amount of free protons. Thus, adding Liquid Miracle-Grow to soil will lower the pH of the soil over time, making it more acidic. Lowering the pH can be dangerous to plants and the microorganisms within the soil. If the soil conditions become too acidic, subsequent generations of plants and bacteria may be unable to sustain growth. As soil conditions are already becoming increasingly acidic due to acid rain, one wonders whether the short term benefits of Miracle-Grow are worth the potential long-term damages to the soil.

In this experiment, students will use an electrode to measure the pH of the Liquid Miracle-Gro Plant Food before and after it passes through soil. These values will be compared to the values obtained for regular water before and after it passes through soil.

Procedure

8) Prepare two large funnels by scrunching two pieces of cheesecloth at the base of each one so as to plug it. Stuff cheesecloth as tightly as possible. Label one of the beakers “Miracle-Gro” and the other beaker “Water”. Place a glass beaker (1000mL) beneath each funnel.
9) Use one of the polypropylene beakers (400mL) to scoop out dirt from the potting soil bag. Fill the beaker to the brim. Tap the beaker on the table to ensure the soil settles down into air spaces. Pour one full beaker of soil into each large funnel and lightly pack the soil with seeds.
10) Obtain two polypropylene beakers from the teacher, one filled with 300mL of the Liquid Miracle-Gro solution and one with 300mL distilled water.
11) Using the electrode, record the pH of both solutions. Take three pH readings for each solution and use the average of the three readings as the pH of that solution.
12) Add each solution to the appropriately labeled funnel. When pouring the solution over the solution, pour very slowly and attempt to cover all of the visible soil with solution.
13) After each solution has passed through the soil and has been completely collected in the glass beaker beneath the funnel (i.e., no solution is dripping from the glass funnel) record the pH of the solution that has passed through the soil. Once again, take three measurements and use the average as the pH for that solution.
14) Over the next several weeks, water both plants with 300mL of distilled water every 3-4 days. While watering record any unusual odors or differences between the two plants. After 10 days, add another 300mL of Liquid Miracle-Gro Plant food to the funnel labeled “Miracle-Gro.”

Results

	Avg pH before soil	Avg. pH after soil	Difference Between Averages
Distilled Water	**5.83**	**5.80**	**0.03**
Liquid Miracle Grow	**7.25**	**6.98**	**0.27**

Describe any differences between plant growth, or any other differences between the two plants that were observed.
The Liquid Miracle Grow takes a longer period of time to pass through the soil.

Discussion

5) Compare and contrast the before and after pH for the plain water and the liquid Miracle-Gro.

There is a noticeable change in pH in the Liquid Miracle-Gro before and after passing through the soil, whereas the water had no noticeable change.

6) Miracle-Gro contains a substantial amount of ammonium (NH_3). Ammonium is a weak base. How do you think ammonium contributed to the pH measurement of the Liquid Miracle Grow before it was added to the soil?

Ammonium made the Liquid Miracle-Gro solution slightly basic.

7) Which seemed to take longer to pass through the soil, the Liquid Miracle-Gro or the distilled water? Why do you think one took longer than the other one?

The Liquid Miracle-Gro took a longer amount of time to pass through the soil, likely because as it passed through the soil it underwent reactions with the bacteria.

8) Did one of your plants smell a bit like vinegar? Why do you think that plant would smell like vinegar while you watered it, but the other one did not?

After watering the soil in which the Liquid Miracle-Gro was originally added, a distinct acidic odor could easily be smelled after each subsequent watering (with distilled water).

Equipment Order Information:

Item	Cat. No.	Current Quantity
Glass beakers (1000mL)	89000-212	8
Polypropylene Beakers (400mL)	89000-206	8
Glass Funnels (150mL)	89000-474	6

Lint Free Wipes	82003-820	2 boxes