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|  | Procedure  Compost: For the first part of my research project, I created a [lettuce based compost and a potato-based compost.](http://docs.google.com/images/total.gif)  Step 1: The first step in creating two identical compost piles was choosing a spot that could be protected from the weather yet large enough for two piles could be built side-by-side. I chose an area adjacent to my house in the side yard. It was shady, protected from the wind, and was easily accessible.  Step 2: In order for me to determine how much lettuce, potato, and straw I would need to conduct the experiment, It was necessary to calculate what is known as the C/N ratio. The C/N ratio is defined as "the amount of bulky, dry high-carbon materials to dense, moist, high-nitrogen materials" (p.140 Basic gardening book). The ideal C/N ratio for compost organisms is between 25:1 and 30:1. Once I decided that lettuce, potato, and straw were going to be my organic materials, I needed to figure out how much of each I would need. In order for me to calculate the C/N ratios, I had to consult Appendix A of the On-Farm Composting Handbook. From the book I drew the values for: the amount of moisture that made up each ingredient (%moisture), the amount of nitrogen that made up each ingredient (%nitrogen), and the natural C/N ratios of the ingredients. Once I knew the %nitrogen and the C/N ratio, I was able to find the amount of carbon that made up each ingredient (%carbon). I now knew the four variables, so I could calculate how much straw I would need to go with [10 lb. of potatoes](http://docs.google.com/images/finpot.gif) and 5 lb. of lettuce for a 30:1 C/N ratio. For the 30:1 C/N ratio, I needed to add .8 lb. of straw to the potato compost and 4.2 lb. of straw to the lettuce compost. (look at the Cornell homepage for equations and calculation instructions)  Step 3: Once I chose the area and calculated the amount of straw that I needed, I collected the materials that I would need for the experiment. These included:  1. 40 lb. of backyard sand  2. 10 yd. of black plastic compost bin material  3. Thermometer (oF)  4. pitch fork (for aerating compost by turning)  5. 5 lb. straw (a large garbage bag full)  6. 10 lb. russet potatoes (sliced for easier decomposition)  7. 5 lb. lettuce clippings  8. plastic bags (rain cover)  9. 10 lb. soil from yard  Step 4: After collecting my materials, I used the black plastic material to form two bins that were 28 inches tall and had a diameter of 19 inches. After securing the bins, I added 20 lb. of sand to each bin as a bottom layer. I then added the [10 lb. of potatoes](http://docs.google.com/images/potato.gif) and .8 lb. straw to one pile and[5 lb. lettuce](http://docs.google.com/images/lettuce.gif) and 4.2 lb. straw to the other. My last step was to disperse 2.5 lb. top soil into each container and then add water until the consistency of a "wet sponge" was reached. I then took the temperature and stirred (aerated) the compost once a week.  Planting: To test the effectiveness of the compost, I planted a leafy vegetable [(lettuce](http://docs.google.com/images/potlet.jpeg)) and a root vegetable ([radish](http://docs.google.com/images/potrad.jpeg)) using the compost as soil. In order to control the variables that existed in this experiment, I treated each sample as similarly as possible.  Step1: I purchased three identical plastic bins that were 6 inches deep, 6 inches wide, and 18 inches long with two drainage holes in the bottom. I then partitioned the radish bin with a piece of wood covered in duct tape. The next step was to choose granite river rocks from my front yard and place them in the bottom of the bins. These rocks were used to give maximum drainage underneath the soil and to not allow soil to clog the drainage holes at the bottom of the bins.  Step 2: I placed four inches of my compost-soil mixture on top of the rock layer. The first bin was filled with only lettuce-based compost, the second bin was filled with only potato-based compost. The third, partitioned bin, had lettuce-based compost on one side and potato-based compost on the other.  Step 3: I now used a piece of wood that would furrow the soil in a straight line so I could get a consistent distance between the rows of seeds and a consistent depth of seed planting. I planted the radishes 1/2 inch below ground level and the lettuce 1/4 inch below ground level. I then covered up the seeds with soil and then watered the seeds.  Step 4: In order to protect my plants from a number of organisms, [I mounted them on top of empty paint cans](http://docs.google.com/images/troughs.gif) so all three stood nearly a foot off of the ground. I watered the plants as needed and thinned the sample size when the plants germinated.  Measurements- Plant Mass and T-testing  Well known statistical principles offer a way to decide if differences measured in an experiment are due to the conditions controlled by the experimental design or due only to chance. In the case of my experiment, I took a small sample of the early scarlet globe radish and a small sample of green leaf lettuce plants. To measure the effectiveness of a particular compost on a particular plant, I took the mass of all of the plants in each sample planter.  In order to weigh the plants, I first had to [harvest the plants](http://docs.google.com/images/letout.jpeg) from the compost soil with great care. This care was taken so I could accurately weigh not only the visible leaves, but the root system as well. I used a process in which I placed the unbroken soil into a large bucket of water to dissolve the surrounding dirt. After submerging several plants that were attached in a piece of soil, I was able to separate each plant individually and place them into the next bucket of water. In the second and third bucket along the row, I cleaned out the root structures which were filled with organic matter and clumps of soil. I cleaned these to attempt to have as close to the true mass of the plant as possible. After cleaning, the plants dried for ten minutes and then were weighed. I used the same process to harvest and clean every single plant.  To weigh each plant, I used an [Ohaus triple beam balance](http://docs.google.com/images/weight.jpeg). I then broke the plants into four different categories so I could compare like samples. These categories were: radish plants in lettuce compost, radish plants in potato compost, lettuce plants in lettuce compost, and lettuce plants in potato compost. After categorizing and then weighing every plant, I was able to find the average mass of each of the four categories. The average weight of each category is also known as the mean mass. After calculating the mean masses, I calculated the standard deviations for every sample. The standard deviation is the distance from the mean. The sum of the standard deviations in a category, divided by the number of samples in that single category, is also known as the standard deviation. I now have a mean mass and a standard deviation for each of the four categories.  Once I computed the standard deviation and the mean from each set, I again separated the four categorized samples. I compared the radish plant in lettuce compost to the radish plant in potato compost (T-test 1). I also compared the lettuce plants in the lettuce compost and the lettuce plants in the potato compost (T-test 2). To test whether there was a statistically significant difference between the two radish samples and the two lettuce samples, I conducted a study called the two sample T-test. The two sample T-test tells the statistician whether a difference between the two radish means or the two lettuce means happened by chance. It can also tell the statistician that there is another reason for the difference (a statistically significant difference).  I did this test at the 95% confidence level. The 95% confidence level literally means that the T-test that I ran would occur the same way 95 times out of 100. In an example, 5 out of 100 could reject the hypothesis, while the other 95 samples taken would support the hypothesis. This type of error is associated with all statistical analyses as they are not foolproof.  If you would like to learn more about this process or would like to see why I chose the T-test instead of another type of test, please read chapter 6 of The Basic Practice of Statistics.  I will have to do the two-sample T-test twice. This is because I want to compare the means of the radish plant in the potato compost to the radish plant in the lettuce compost (test 1) and I also want to compare the means of the lettuce plant in the lettuce compost to the lettuce plant in the potato compost (test 2).  **Test 1**  The first statistical analysis that I ran was a comparison of the radish plants in the potato compost versus the radish plants in the lettuce compost. This analysis is called the Two sample T-test. It involves taking the mean and the standard deviations of the masses of the radish in both composts and then comparing them. This procedure can be used provided that the sample size is greater then 15 and the sample is a Simple Random Sample that can be represented by a normal curve. I will conduct a five-step hypothesis test that compares the mean weight of the radish in the potato compost (µ1) to the mean weight of the radish in the lettuce compost (µ2).  Step 1:  Ho: µ1 = µ2  Ha: µ1 does not equal µ2  Step 2:  Sample Data: Population Data:  x1 = 2.524615385 a level = 95%  Sx1 = 1.486785071 tcritical = 2.021  n1 = 26  x2 = 3.148695652  Sx2 = 1.451526796  n2 = 26  Step 3:  46.522 rounds down to a degree of freedom of 40. At the degree of freedom 40 at the 95% confidence level, the tcritical is 2.021.  Step 5: We fail to reject the hypothesis Ho, that µ1 = µ2. This means that there is no statistically significant difference between the average weight of radish planted in potato compost and the average weight of radish planted in lettuce compost.  **Test 2**  In this test, I compared the average mass of the lettuce grown in lettuce compost (m1)and the lettuce grown in potato compost (µ2).  Step 1:  Ho: µ1 = µ2  Ha: µ1 does not equal µ2  Step 2:  Sample Data: Population Data:  x1 = 1.183461538 a level = 95%  Sx1 = .74951687 tcritical = 2.021  n1 = 26  x2 = 2.65875  Sx2 = 1.705003547  n2 = 32  Step 3:  45.7214 rounds down to a degree of freedom of 40. At the degree of freedom 40 at the 95% confidence level, the tcritical is 2.021.  Step 5: We reject the hypothesis Ho, that µ1 = µ2. This means that there is a statistically significant difference between the average weight of lettuce planted in potato compost and the average weight of lettuce planted in lettuce compost. The lettuce planted in the potato compost is significantly larger in this sample which refutes my written hypothesis.  Other Tests:  In order to gain perspective on my experiment, I tested the phosphorus levels, nitrate levels and the pH on the four respective soils.  pH: pH is the amount of hydrogen ions present in a sample. It is measured on a negative logarithmic scale that generally runs between 1 and 14. 1 is the most acidic compound and 14 is the most alkaline or basic compound. To take the pH of the soils, I used a small piece of pH paper and let it rest in the soil for a short time. I then compared the sample paper to the side of the pH paper dispenser. I took the pH of the two piles of finished compost, and then I took the pH of the soil in each planter.  Nitrate: The nitrate test that was available to me was a water-based test. In order to attain a measurable sample of nitrate, it was necessary for me to filter the soil sample several times.  Step 1: As the first step, I measured out 11/4 cups of tap water and poured it into a beaker. I then measured out one ounce of soil, and stirred the water until the soil was suspended. I used a pieces that I cut from a Hanes undershirt to use as a filter.  Step 2: To filter the water and soil mixture I held the T-shirt piece across the top of the beaker and then poured the mixture through it into another beaker. I then discarded the "filter". I repeated this process twice more for a total of three filtrations for each water sample.  Step 3: Once the sample was filtered, I poured the sample into the given test container. I then added two drops of nitrate activator and inverted the bottle several times while allowing one minute to pass. I then used a glass ampule to take the sample. After two minutes passed, I compared the ampule to the given color code and was able to gauge the relative amount of nitrates in parts per million of each of the four soils.  Phosphate: Like the nitrate test, the phosphate test was water-based. It was necessary for me to filter the samples so I decided to use the same process of filtration.  Step 1: As the first step, I measured out 11/4 cups of tap water and poured it into a beaker. The second step was for me to measure out one ounce of soil. I then stirred in the soil and cut out a piece from a Hanes undershirt to use as a filter.  Step 2: To filter the water and soil mixture I held the T-shirt piece across the top of the beaker and then poured the mixture into another beaker. I then discarded the "filter". I repeated this process twice more for a total of three filtrations for each water sample.  Step 3: Once the sample was filtered, I poured the sample into the given test container. I then added a packet of phosphate test activator, shook for one minute, and then used a glass ampule to take the sample. After ten minutes passed, I compared the ampule to the given color code and was able to gauge the relative amount of phosphates in parts per million for each of the four soils. |

*This Web Site is Best viewed with 256 or more colors.*

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