Plants Density's Effect on Potassium

Emily Brooks, Annie Cobb, Ugochi Ihenatu, and Arnnette James

Abstract

Plants use large amounts of potassium for nutrients and growth. When higher amounts of potassium were found in quadrant 1 of site 4 compared to the other 3 quadrants during the biota survey (E.S.S.R.E 2011), our group designed an experiment to test if plants were absorbing the potassium. We hypothesized that the more plant density there was, the less potassium there would be in the soil. In order to prove this, we measured the plant density in Site 4, because it has a lot of similar plant life species. We collected soil samples for five days from five areas that had different amounts of plant density. We then tested each sample for potassium. Our hypothesis turned out to be incorrect, but we found some data hinting toward another factor affecting potassium in Site 4.

Introduction

All living things need a large amount of the chemical element potassium in their cells in order for them to survive. Plants, in particular, need potassium. Potassium makes plants become more resistant to stresses such as extreme temperatures, droughts, and pests. It also provides plants with their means to water. In a process known as osmoregulation, plants use potassium to control the transportation of water through the xlem. Potassium also helps with the elongation of cells during plant growth, and it aids in the opening and closing of the stomates. That helps with cooling and carbon dioxide for photosynthesis (McAfee, 2008). Furthermore, potassium increases the amount of protein being made within the plant (Schmitt and Rehm, 2002).

Without an adequate amount of potassium, many parts of a plant begin to weaken. Plants are no longer able to handle stresses as sufficiently and are more susceptible to diseases. The coloring of the plant also changes dramatically. Many of the leaves start to turn yellow as the tissue begins to die, and this loss of photosynthesis causes a plant's growth to become stunted (Schmitt and Rehm, 2002). Without potassium, plants are in danger of becoming unhealthy.

The source of potassium for plants is soil; that is where they absorb potassium through their roots. As the eighth most common element in the earth's crust, potassium can be found in many sources (Groiler, 2011). Unfortunately, only a small amount of potassium in the soil is available to plants. Most potassium in the soil (up to 98%) cannot be absorbed by plants. Such potassium, called unavailable potassium, derives from feldspars and micas mineral. But over long periods of time, this potassium is released from these minerals by erosion to form what is known as slowly available potassium. Slowly available potassium can be found in layers of clay and is still very hard for plants to use. But when the clay holding the potassium becomes wet, a new form of potassium (known as readily available potassium) is created. This readily available potassium is a water soluble solution which plants can now absorb (Schmitt and Rehm, 2002).

Other factors can also influence the absorption rate of potassium. Two factors which affect potassium consumption are temperature and aeration. In order for potassium to be absorbed, the temperature of the soil has to be between certain degree 15.6-26.7 degrees Celsius. Roots also need adequate amount of oxygen from the atmosphere in order to be able to absorb what potassium is accessible in the soil (Schmitt and Rehm, 2002).

In the 2011 E.S.S.R.E. Biota survey of Site 4 (N 39.35733; W 076.63840) an unusually high amount of potassium was found in quadrant one compared to the other three quadrants. According to the E.S.S.R.E. 2011 Biota survey, there was average of 137.5 ppm potassium in quadrant 1, while quadrant 2 only had 87.5 ppm, quadrant 3 only 95 ppm, and quadrant 4 only 100 ppm (E.S.S.R.E 2011). The survey also revealed that quadrant 1 is heavily denuded while the other quadrants are densely inhabited by the jewelweed that dominates Site 4. Hence, given the correlation between available potassium in the soil and the quantity of plant life there, we hypothesized that the areas with greater plant density would have more potassium absorbed resulting in lower levels in the soil.

Methods

Five locations were chosen in E.S.S.R.E. Site 4 (N 39.35733; W 076.63840) depending on differences in the density of plant ground cover: one with 100-75% ground cover, one with 74-50% ground cover, one with 49-25% ground cover, one with 24-1% ground cover, and one with 0% ground cover. Density was determined using a Project Globe densiometer (Globe, 1997), and Site 4 was chosen because of its monoculture of jewelweed to control for plant diversity. A soil sample 15 cm deep with a diameter of 2 cm was taken from each of the 5 locations using a metal soil auger. All samples were then tested for potassium (ppm) on the same day using the La Motte Combination Soil Model STH-14 Test Kit. New samples were collected from the same 5 locations daily for five days on 7/22/2011, 7/23/2011, 7/25/2011, 7/26/2011, and 7/27/2011.

Results

Figure 1

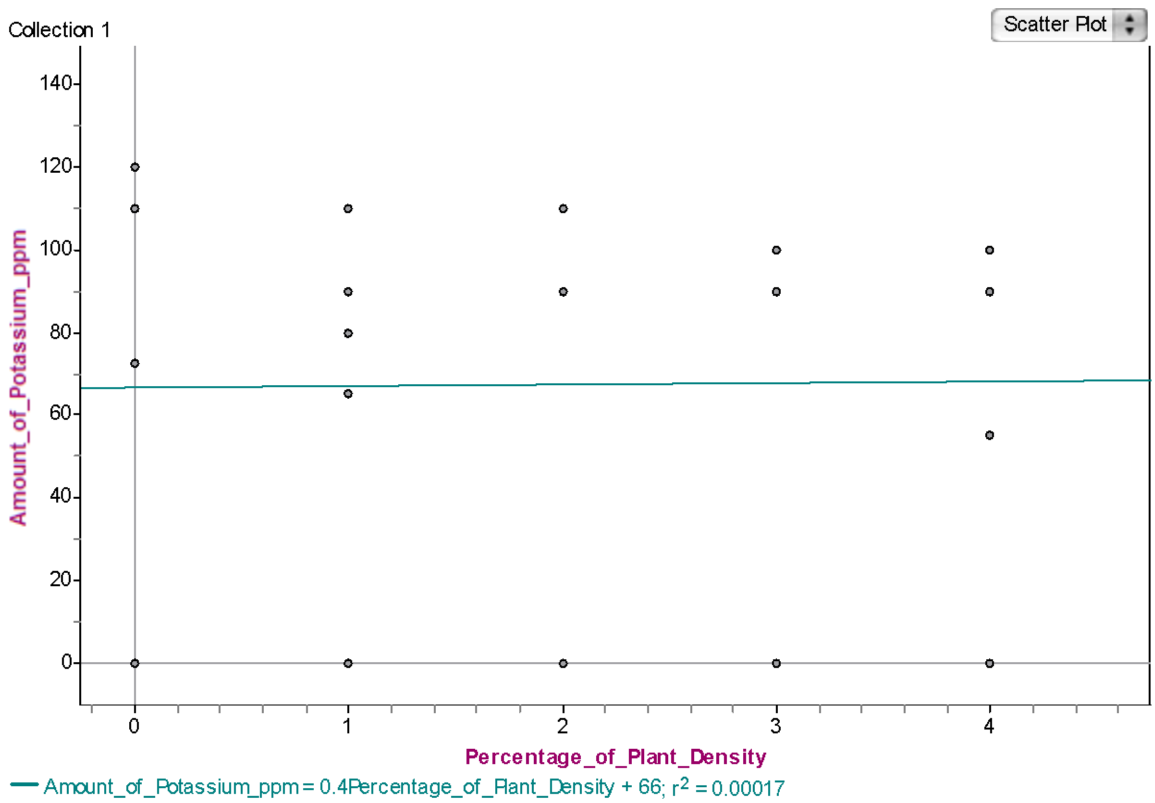


Figure 2

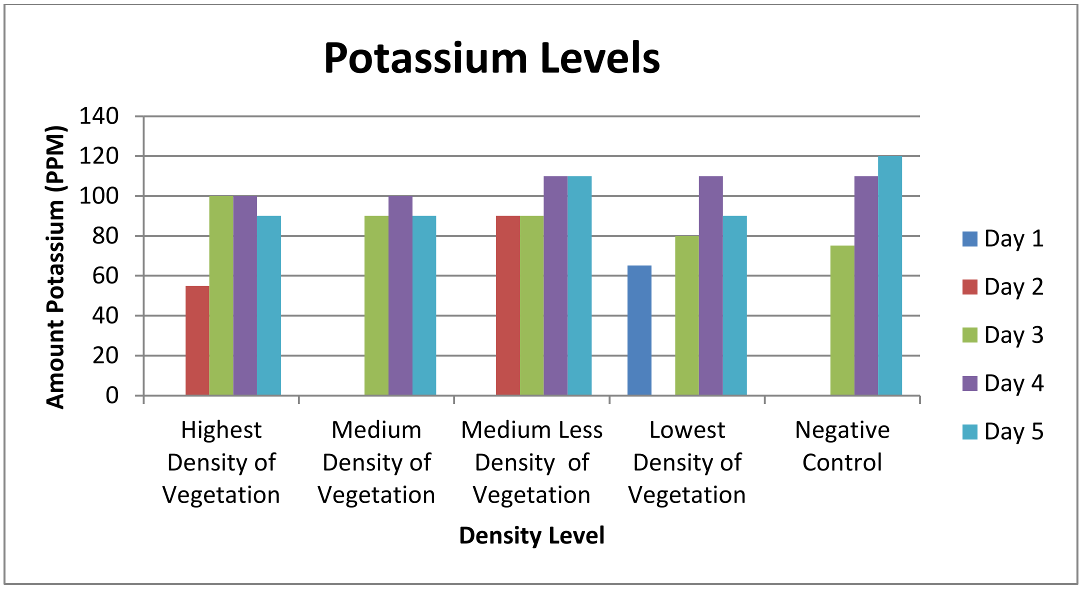
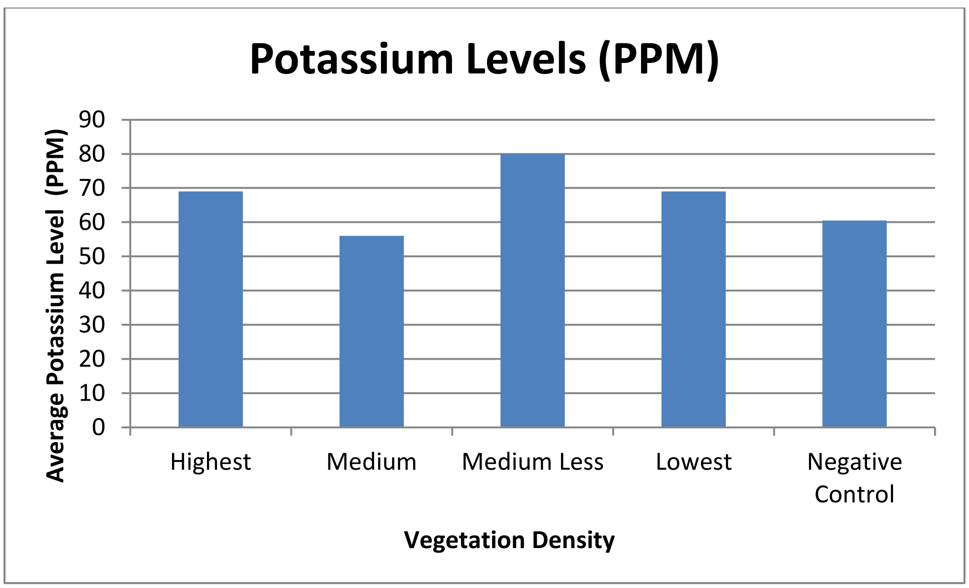


Figure 3



Discussion:

Our hypothesis that the plant density impacts the amount of potassium is incorrect. As figure 1 indicates, there is no positive or negative correlation between the plant density and the amount of potassium in the soil there. However, the data indicated another possible factor which could have affected the difference in the potassium in site 4. As figure 2 shows, there is a general upward trend in potassium levels from day to day in all sampling locations. The increase of potassium led us to believe that another factor is influencing the test sites. An examination of the locations of the different sites led us to notice that the data could have been influenced by the stream; it varies in distance between the 5 sites where we took our soil samples. Figure 3 shows that the 100-75% density location with an average of 60 ppm and the 49-25% density location with an average of 80 ppm had the highest amounts of potassium, but these locations were the farthest away from the stream. Similarly, the 74-50%, 24-1%, and the 0% density locations were significantly closer to the stream. Therefore, it is possible the irregularities can be explained by the locations of the test sites. The variation could be the water from the stream leaching the potassium from the soil close to it. Additional testing to look for the possibility of leaching is the next logical course of action to investigate.

References:

Encyclopedia Americana.(2011). Potassium. Grolier Online :

http://ea.grolier.com/article?id=0319900-00

Erickson, L., Fuhrmann, M.(2011, July 26). Soil Remediation. Access Science:

http://www.accessscience.com

E.S.S.R.E. (2011) E.S.S.R.E. Microclimate Statistics. :

http://www.rpcs.org/essre/ESSREMicroclimateSurvey.htm

Globe. (1997). Quantitative Land Cover Sample Site Protocol. Retrived from:

http://globe.gov/sda/tg/landcover/Quantitative.pdf

McAfee, J. (2008). Potassium, A Key Nutrient for Plant Growth. Department of Soil and Crop

Sciences:
http://jimmcafee.tamu.edu/files/potassium%20a%20key%20nutrient%20for%20plant%20growth.pdf

Rehm, G. , Schmitt, M. (2011). Potassium for Crop Production. University of Minesota:

http://www.extension.umn.edu/distribution/cropsystems/dc6794.html

Spector, C. (2010). Soil Fertility: How Does Your Garden Grow. Prentice Hall, Inc.:

http://soil.gsfc.nasa.gov/soilfert/npk.htm

Acknowledgement:

We would like to thank the following organizations and funders for funding our program, Human Capital Development, Inc., Larry and Kathy Jennings, and Dr. Holliday Cross Heine. We would like to thank Mr. David Brock, the E.S.S.R.E. director, and his teaching assistants, Maddie Muth, Chelsea Roberts, and Ella Gensheimer, for helping us throughout the program. We would also like to thank Roland Park Country School, for hosting us and letting us experiment on their property.