THE EFFECT OF VARIOUS AMOUNTS OF CLAY ON POTASSIUM LEVELS IN SOIL

REPORT BY: GLORIA WIGGAM, SHREYA RANGARAJAN, MADDY SHAY, AND ELLA FRANKEL

Abstract

Potassium is an important chemical element vital to the population of plants and clays levels in the soil. Research has shown that increased levels of clay in the soil will result in higher levels of potassium. Research also has shown that the levels of clays will be higher at the bottom of a hill because of greater water solubility. However, an anomalously high level of potassium was found in E.S.S.R.E Site 3, which is located at the top of a hill. Before starting our experiment, we hypothesized that this high level of potassium was due to the higher levels of clay alleged to have been found there. We gathered soil samples from four locations based on their variation in clay percentage to test for soil texture and levels of potassium for five consecutive days in the E.S.S.R.E research sites. We confirmed the traditional correlation between the amount of clay in the soil and the level of potassium located there. However, an error in the original statistical analysis that was the source of our hypothesis prevented us from affirming or denying the said hypothesis.

Introduction

Potassium is a vital nutrient for plants which helps them survive through extreme temperature and weather. It also quickens the pace of the enzymatic processes which enable plants to grow. In addition, potassium plays a key role in the osmoregulation process that enables a plant to control the uptake of ground water.

Three major types of potassium are present in the soil: unavailable, nonexchangeable or slowly available, and available potassium. 90%-98% of the potassium in soil is the first kind and is held in micas and feldspars where plants cannot access it (McAfee n.d. and Rehm, Schitt, 2002). Eventually, through exposure to water through rainfall and run-off, these minerals release the potassium over long periods of time, and this released potassium becomes part of either the slowly available potassium or the readily available potassium (Rehm, Schmitt, 2002).

Slowly available potassium represents 1%-10% of the potassium found in the soil and is found mainly in clay minerals. It acts as a reserve source in the soil and becomes readily available potassium as it becomes trapped in the layers of the clay. (McAfee n.d. and Rehm, Schitt, 2002). This 1%-2% of potassium in soil is then the exchangeable or available potassium that plants can actually use (McAfee, n.d.).

During the 2012 E.S.S.R.E Biota survey (E.S.S.R.E, 2012), we found that there was more potassium at E.S.S.R.E Site 3 (105.83ppm) than ESSRE Site 4 (39.58ppm; p=.002) (E.S.S.R.E, 2001). Since both rain water and the stream that runs through E.S.S.R.E Site 3 it should wash any available potassium down the hillside located there, there should have been statistically more potassium in E.S.S.R.E Site 4 rather than the other way around. However, the survey also revealed that there was a greater percentage of clay in the soil in E.S.S.R.E Site 3 (55.92%) than E.S.S.R.E Site 4 (3.08%; $p=4.134x10^{-9}$). Knowing that availed potassium is found in soil clay, we hypothesized that the greater percentage of clay found in the soil might be the reason in higher amounts of potassium in E.S.S.R.E Site 3.

Methods and Materials

Fifteen different locations were chosen in E.S.S.R.E sites 1, 2, 3, and 4 (E.S.S.R.E, 2001) based on the differences in the average amount of clay (see table A) found in data for the soil samples taken from 2001 to 2009 (E.S.S.R.E, 2009). Soil samples from each location were extracted and tested for potassium (ppm) and their percentages of clay determined every day for five days.

Site 1 Quadrant 1	19.37%	Site 3 Quadrant 1	14.68%
Site 1 Quadrant 2	15.78%	Site 3 Quadrant 2	13.72%
Site 1 Quadrant 3	8.6%	Site 3 Quadrant 3	9.98%
Site 1 Quadrant 4	11.42%	Site 3 Quadrant 4	10.07%
Site 2 Quadrant 1	13.01%	Site 4 Quadrant 1	8.41%
Site 2 Quadrant 2	16.02%	Site 4 Quadrant 2	6.08%
Site 2 Quadrant 3	14.24%	Site 4 Quadrant 3	4.50%
Site 2 Quadrant 4	13.08%	Site 4 Quadrant 4	4.33%

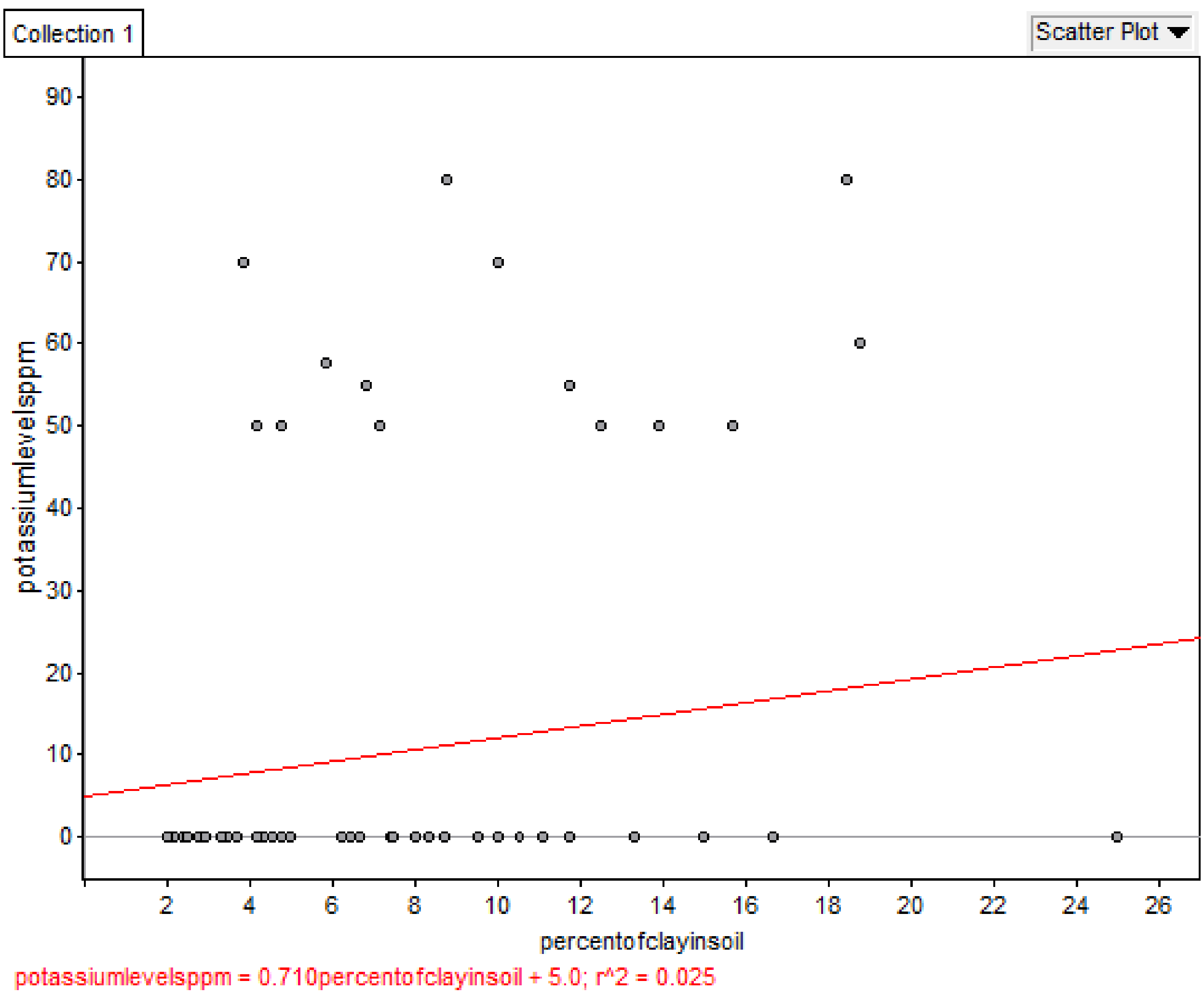
Two different samples were taken from each of the locations. First, a cylinder of soil, 2 cm in width and 15 cm in depth, was extracted to test for potassium.

Second, a level garden trowel was taken from the soil surface to test for soil texture.

To perform the soil texture test on each sample, the soil collected by the trowel was placed to a height of 2 cm in a flat-bottomed, cylindrical container with a diameter of 5 cm that was 7cm tall. Tap water was then added to container to a height of 6 cm. Next, 1 ml of a 0.7% sodium phosphate solution of Palmolive Eco dishwashing detergent was added to the soil and water mixture. The container was capped and shaken for one full minute and was then left to sit undisturbed for 24 hours. The percentage of the clay was then calculated by dividing the height of the layer of clay (top layer of settled soil) by the height of the column of settled soil.

To determine the amount of available potassium in the soil at each location, the soil from the extracted soil core samples were tested using the LaMotte Combination Soil STH-14 Test Kit.

Results



This is a graph of the percentage of clay in the soil vs. the potassium level (ppm) of the soil from the different sample sites. The data show that higher levels of clay do indeed result in higher levels of potassium.

Discussion

Based on the original analysis of the Biota survey (E.S.S.R.E 2012) the idea behind our investigation was that the higher percentage of clay in E.S.S.R.E Site 3 (55.92%) caused the high levels of potassium (105.83ppm). We hypothesized that given the known relationship between clay and potassium (Rehm, Schmitt, 2002) the reason for such higher levels of potassium at the E.S.S.R.E Site 3 was due to the much higher percentage of clay there.

Over the course of our investigation we learned that a mistake was made in the original statistical analysis and that there was low percentage of clay (9.78%) in E.S.S.R.E Site 3. Therefore, the original supposition behind our hypothesis was false. Hence our data can neither support nor disprove our hypothesis. However, as graph 1 clearly shows, the data we collected reconfirms the known correlation between clay levels and available potassium levels.

Given that the original statistical analysis **did** support that there was an unusually high level of potassium in E.S.S.R.E sight 3 ($p=.002$) existed we would have to continue research to see why there were such high levels. In the future, we would look for other aspects of the soil in E.S.S.R.E sites that might be the cause of the high potassium levels. Two other factors in the soil that were observed to have unusual values in this year's Biota survey (E.S.S.R.E 2012) were phosphorous levels and pH levels. Given that these factors are also known to influence the amount of potassium, reexamining the amount of phosphorous in and the pH of the soil in E.S.S.R.E Site 3 would be a logical starting point towards explaining the excess potassium found there this year.

Acknowledgements

We would like to thank our generous sponsors Human Capital Development, Inc, Larry & Kathy Jennings, and Dr. Holliday Cross Heine for supporting our research this year.

References

Crossman, C., Griffith, M., Parkison, B., & Woods, A. (Undated). *Two-Component Sensory Transduction Systems*. Retrieved from https://www.bio.cmu.edu/courses/03441/TermPapers/99TermPapers/TwoCom/main.html

E.S.S.R.E. (2012). *E.S.S.R.E.GeneralDescription of The E.S.S.R.E. Survey Sites.* Retrieved from E.S.S.R.E.: http://essre.rpcs.org/ESSRELocations.htm

E.S.S.R.E. (2012). *E.S.S.R.E. Microclimate Data Base*. Retrieved from E.S.S.R.E.: http://essre.rpcs.org/ESSREMicroclimateSurvey.htm

McAfee, J. (Undated). *Potassium, A key Nutrient for Plant Growth*. Retrieved from TAMU: http://jimmcafee.tamu.edu/files/potassium%20a%20key%20nutrient%20for%20plant%20growth.pdf

Rehm, G., & Schmitt, M. (2002). *Potassium For Crop Production*. Retrieved from University of Minnesota Extension: http://www.extension.umn.edu/distribution/cropsystems/dc6794.html