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Effects of Personal Gardens on the Reduction of Atmospheric CO₂ and Climate Change

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Abstract

This study aims to explore the long-term benefits of home gardening if every student at Pepperdine University were to hypothetically sustain their own home garden in the state of California and the effect that this would have on state carbon absorption as a means of decreasing atmospheric CO₂ and reducing further climate change.

Introduction

Climate change is currently an immense global issue that people are not taking the time to address. Many people do not realize that there are simple ways to help stop or reduce global warming. We believe that if more people chose to grow a home garden, it would aid in fighting global warming because of the carbon dioxide that the plants would use to turn into oxygen. Excess carbon emissions are a huge contribution to global warming. With more plants on the earth, we could decrease the carbon in the atmosphere. We hypothesize that if every student at Pepperdine were to have a 6ft square home garden, then it would significantly aide in fighting global warming and climate change.

Lynn Ellen Doxon in her article about sustainable horticulture states that these high carbon dioxide levels are caused by our system of food production, development, transportation, and population concentration; we must now look for ways to re-create the carbon dioxide fixing effect that natural systems once had. Since there is an abundance of carbon dioxide in the air, we need to find ways to reduce that and planting more plants is the perfect way to start. The amount of carbon dioxide an individual plant will fix depends on the type, condition, size, and the environment. In brighter and warmer conditions a plant that photosynthesizes during part of the day, otherwise known as a C-4 plant, will be able to fix more carbon. C-4 plants include various flowers and grasses, but not trees (Doxon). Therefore, a home garden is a very practical way to reduce carbon dioxide in the environment.

Michael G. Ryan’s experiment on effects of climate change on plant respiration states that “plant respiration is a large and sensitive component of ecosystem carbon balance.” The net ecosystem carbon flux will change as the balance between photosynthesis and respiration changes. Respiration is especially sensitive to high temperatures and global warming has increased those temperatures, causing forest ecosystems to die younger. Also the lack of biodiversity in forests is making it harder for the plants to try to adjust to the rise in temperature. We tested to see if having a home garden would decrease carbon dioxide levels in the atmosphere. To test this we tested the photosynthesis, conductance, and internal carbon dioxide in two leaves of a tomato plant and a raspberry plant. We also measured the average size and amount of leaves on those plants. This allowed for us to see how much carbon typical home garden plants would remove for the atmosphere and from there we can calculate how much carbon would be removed if every student at Pepperdine were to have a home garden.

Results

In order to test the effects of home gardens on CO₂ absorption, we measured two garden plant species: Solanum lycopersicum (tomato) and Rubus idaeus (raspberry) from the Pepperdine on-campus garden (Figure 1). We took note of each leaf’s photosynthetic rate, conductance, and CO₂ internal (Ci) in order to deduce the amount of CO₂ that is absorbed by each plant, focusing on the photosynthetic rate. We then multiplied this value by the number of average-sized leaves on the plant and converted the units into tons of carbon absorbed per year. In order to demonstrate the effect this would have if every Pepperdine undergraduate student were to hypothetically sustain their own home garden with one of each plant, we multiplied this annual rate by 3,000 students (Figure 2), and this value is a very significant impact on annual CO₂ absorption, proving our hypothesis correct.

Due to the nature of our study, there were several variables involved in attempting to calculate the significance that 3,000 additional small home gardens would have on our environment, such as types of plants, leaf sizes, numbers of leaves, weather conditions, and each plants’ relative photosynthetic rates. During our calculations we attempted to be as precise as possible using the sample garden and its values that we conducted the tests on and multiplied those estimated values by 3,000 undergraduate students for our total carbon absorption in tons per year.

Additionally, there has been ample research conducted regarding atmospheric CO₂ throughout the recent past years due to climate change concerns. One of the most notable examples of CO₂ research is the “Keeling Curve” by Charles David Keeling that illustrates the significant increase in atmospheric CO₂ from 1956 to his death in 2005. As you can see in Figure 3, the amount of CO₂ in the atmosphere in Mauna Loa, Hawaii has been increasing at a steady rate for over the past fifty years. This is a result of less plants on earth to absorb atmospheric CO₂ as well as the increasing excretion of greenhouse gases. Both of those detrimental actions is human-induced. The reason for the fluctuation on the graph is due to the seasonal change every year. The graph hits a relative low-point on the graph in the spring when plants are more prevalent, and inversely the value increases relatively in the winter when vegetation is less pervasive. This research indicates that an increase in vegetation will directly correlate to a decrease in atmospheric CO₂ and thus slow the process of climate change. This led us to conduct this study on a practical method of decreasing atmospheric CO₂ in order to prevent further climate change.

In conjunction with the increased CO₂ levels in general, California itself hold a significant amount of the United States’ CO₂ as seen in Figure 4, but also manages to eliminate that CO₂ at an above-average rate. This rate can be a result of California’s above average surface area and relative greenness in Northern California. Although California is a relatively green state, the “greenness” is, in fact, decreasing annually. The reduction of greenness can be seen according to the NDVI map in Figure 5. This shows that California is less green than the previous year by 0.01%, which may not sound like much of a difference, but over time, this is creating a significant and exponential negative impact on our environment.

Conclusion

Because California’s vegetation is gradually decreasing, and greenhouse gas emissions are exponentially increasing, there is an environmental need for deliberate increased vegetation, which can be done easily and effectively by planting a home garden. According to our empirical data, the quantitative carbon absorption from a home garden creates a substantial impact on atmospheric CO₂ reduction over a year, especially if every single Pepperdine student participated in this meaningful movement.

Literature Cited