The influence of soil pH on the growth of Wisconsin Fast Plants

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ABSTRACT

- Soil pH influences optimal conditions for nutrient uptake and plant growth.
- We measured plant growth parameters including germination, height, biomass, photosynthetic efficiency, and flowering of *Brassica rapa*.
- Neutral pH was the best condition for growth followed by high then low pH.

INTRODUCTION

Quality of plant life

Plants have different conditions on where they thrive and are able to grow properly. Geology is an important factor in this, as that is where plants root. The modern way of agriculture strips soil's nutrients, leaving poor harvests in future years. The lack of nutrients is not the only issue, pollution is known to change soil to be more acidic (Zandalinas et al. 2021). Pollution is only becoming more prevalent, so acidity will become a growing concern.

Darwin's "struggle for existence" is only becoming more of a battle to the death as days pass. The places with habitable lands will only shrink, restricting the number of plants that will be able to grow in the first place, not even touching on the resources other than space. Will there be enough nutrients? Or water? Plants with high nutrients have the strongest growth (Tetsopgang and Fonyuy 2019).

Soil influences availability of important nutrients and microbiomes required for growth. How will plants fare when put into soil with more extreme pH conditions that the microbes they rely on would struggle in? (Clemente et al 2005). Would they be able to survive, or would they struggle to grow and maybe even die before reaching maturity?

Soil pH and Plant Abundance

Plant growth and overall biomass is highly determined by soil pH (Clemente et al 2005). Changes to the soil can cause different outcomes to the plants relying on the soil, and there is no guarantee that they can survive depending on its condition. Low pH for plants is considered stressful to them and prolonged stress is shown to have detrimental effects on biomass (Vallabhaneni 2024).

Objective

What was decided to do was to test and see how *Brassica rapa* handles different levels of soil pH while it grows and see if it is able to survive in certain extremes.

Multiple parameters can be measured to determine success of the plant, height, leaf area, and biomass, all of these parameters will have a higher value when comparing to a plant struggling.

Hypothesis: Plants would grow best in soil that has a neutral pH while comparatively struggling in alkaline and acidic soils.

METHODS

- Study Site: Greenhouse at SUNY Oswego Shineman Center, Oswego, NY
- Three types of soil were used, one was neutral with a pH of 7, one was acidic at 5 and one was alkaline at 9.
- Used the rosette dwarf variant of *Brassica rapa.*
- There were 8 replicate pots for each type of soil with 2 seeds inside of each pot.
- Data parameters collected were plant height, leaf area, and biomass.
- Tools used were rulers, watering can, pots and plant trays.

RESULTS and DISCUSSION

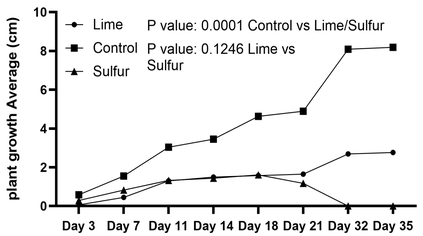

Figure 1. Comparisons between average height of each treatment across the growth time

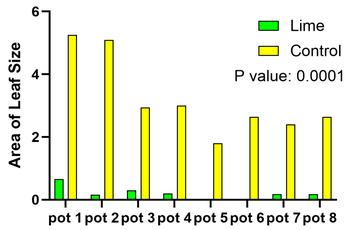

Figure 2. Comparison of mature leaf area between treatments

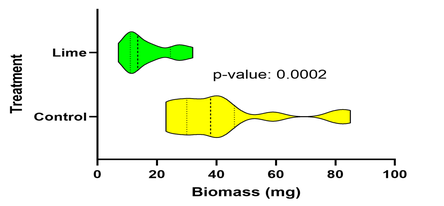

Figure 3: Comparison of biomass in mg vs treatment

Figure 4: *Brassica rapa* seedlings in lime treated soil

Plant height

The control was consistently double the height of both treatments (ANOVA, p= 0.0001) which shows how in comparison to each other plant growth was far more effective when the pH of the soil was neutral which provided greater plant growth (Tetsopgang and Fonyuy 2019)

Plant growth was the worst in sulfuric soil due to low pH which makes sense since lower pH ranges in the soil is bad for plants and cause stress (Vallabhaneni 2024).

Leaf Area

When comparing the area of leaf size, the plants in the control pots was more than six times larger than the leaf size of the plants in the lime pots. This is reasonable as so long as the pH of the soil is kept neutral it can ensure normal growth in leaf size (De Pascale et al 2005).

Biomass

As all the sulfur plants died and been decomposed before harvesting, we only have biomass data for lime treated and control plants. The biomass of control plants were consistently heavier than that of lime treated pots (t-test, p= 0.0002). This is possible since the neutral pH plants had the best conditions for plant growth providing an overall larger biomass (Grinsted et al.1982)

While the plants in the Lime soil fared better than Sulfuric soil and were able to properly survive, it is not as effective as the pH of the soil offers little change for the plants over time when it comes to alkaline sources (Kim et al 2010)

Discussion

Global climate change is having an impact on our plants. Pollutants can cause a dramatic change in soil pH (Zandalinas et al. 2021). Based on our results here, there will likely be increased rates of plant deaths, which reduces the amount of potential carbon dioxide that can be removed from the atmosphere.

In a study of mustard plants, silicon nanomaterials and dolomite were found to assist in the ability for seedlings to grow properly in acidic soils (Hasan et al 2024). Could this be the answer to these concerns? The soil will change regardless, but crop damage can be reduced with supplementation in fields. This does still leave large forests susceptible but reduces risk of entering a food crisis.

Reason for decline in growth in acidic soil is multifactorial. With a lower pH, there are higher concentrations of fungivorous nematodes, which would diminish the mutualistic relationship between plant roots and fungal hyphae (Matute 2013).

Using wood ash as a neutralizer for acidic soil has been supported as a useful supplement (Ibukunoluwa 2015), which supports our results of neutral pH having the most successful plants.

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