Determining the effects of added zinc on plants

2021

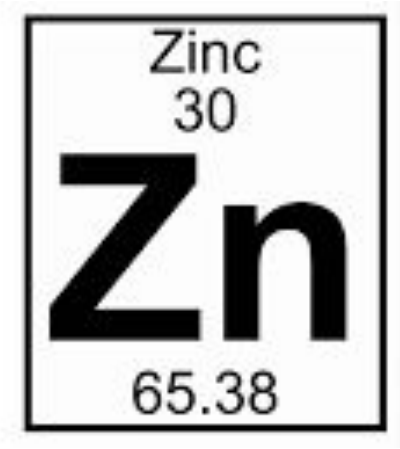
How was the project idea developed?

Background

Background

- The amount of soil on the planet is a finite resource.
- Human activities can increase the amount of zinc released into the environment.

Background



- Zinc is an essential micronutrient, especially for plants.

Zinc deficiency

Zinc toxicity

Rationale, Hypothesis

Rationale

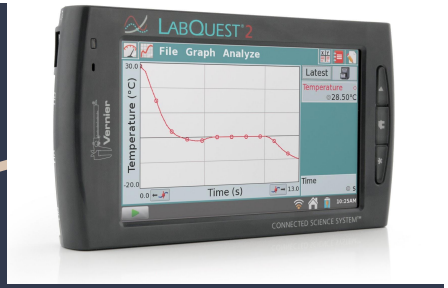
- Since the market for steel is predicted to increase by more than 2 percent between 2020 and 2025, it is important to determine what impacts added zinc has on plants, especially food crops.
- The question guiding the experiment was: **How does added zinc affect the height and chlorophyll content of plants?**

Hypothesis

If the amount of added zinc crosses a certain threshold (> 200 ppm), plant growth would decrease, and chlorophyll content would decrease. However, if the amount of added zinc is between 0 and that threshold, plant growth would increase, and chlorophyll content would increase.

Methodology

Methodology



Materials used:

- 40 *Vigna unguiculata subsp. unguiculata* (hence called Black eyed peas)
- 1 Vernier colorimeter
- 1 LabQuest interface
- 40 Styrofoam cups with a depth of 12.50 cm
- Organic soil (no fertilizers added)
- 40 glass tubes
- Acetone
- Zinc sulfate fertilizer
- Glass cuvettes
- Ruler
- Water
- 4 lamps; each has an LED bulb
- Electronic scale

Methodology

Independent variable: amount of added zinc in the soil.

Levels of the IV: 0 ppm (control), 100 ppm, 200 ppm, 300 ppm

Dependent variable: height of the plants (mm), chlorophyll content (AU)

Controlled variables: amount of water given daily (16 mL), amount of time light was given (8 hours), amount of soil in each cup (100 g)

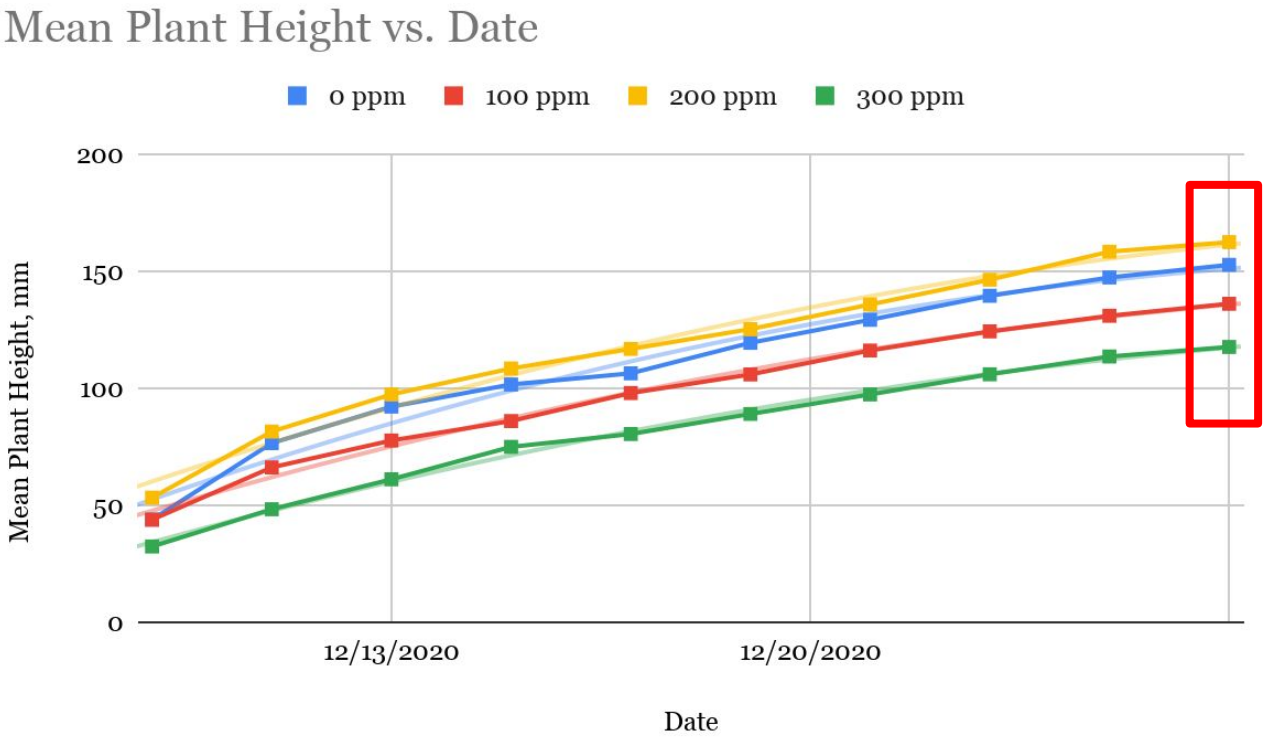
Data

Data

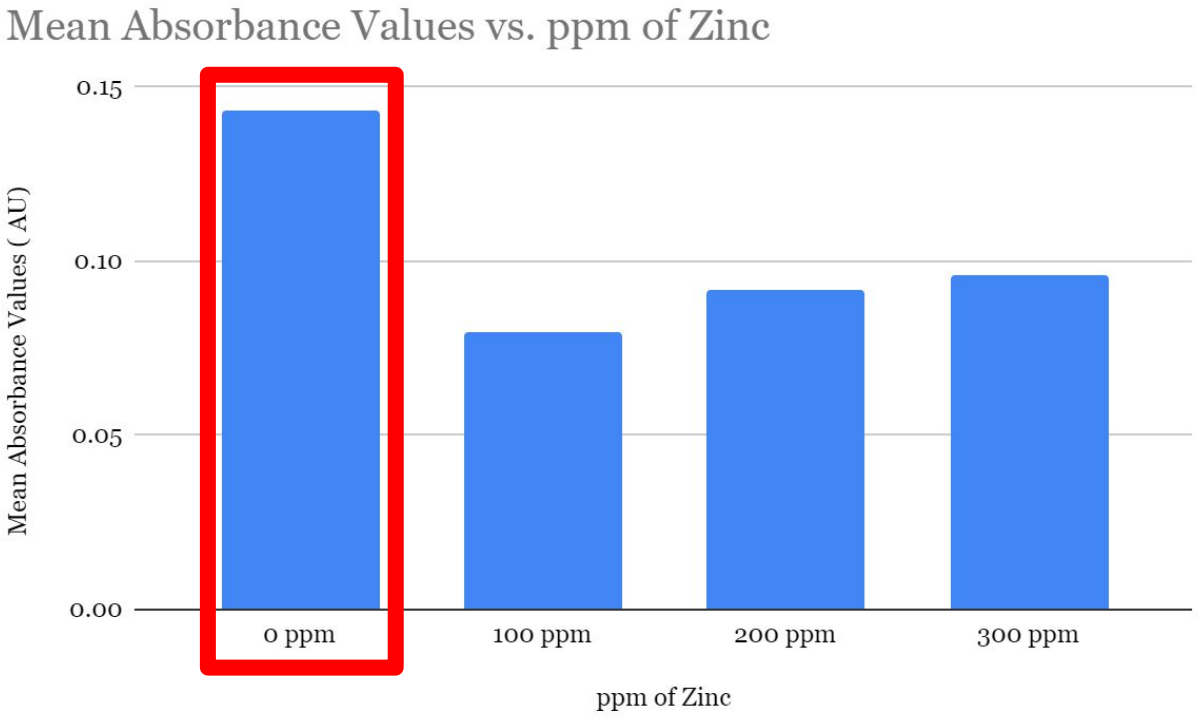
Mean height of plants on any given date, in millimeters.

Mean of Plant Height, millimeters (mm)										
Added zinc ppm	Date (all in the year 2020)									
	12.9	12.11	12.13	12.15	12.17	12.19	12.21	12.23	12.25	12.27
0 ppm	43.87	76.53	92.10	101.57	106.32	119.36	129.18	139.42	147.25	152.65
100 ppm	43.84	66.16	77.64	85.96	97.90	105.85	116.08	124.22	130.89	136.04
200 ppm	53.24	81.48	97.31	108.38	116.76	125.20	135.71	146.30	158.26	162.34
300 ppm	32.38	48.30	61.08	74.92	80.41	88.98	97.31	105.91	113.50	117.58

Data


Mean Plant Height vs. Date
0 ppm
100 ppm
200 ppm
300 ppm
200
150
100
50
0
Mean Plant Height, mm
12/13/2020
12/20/2020
Date

Data


Mean Absorbance Values vs. ppm of Zinc
Mean Absorbance Values (AU)
0.15
0.10
0.05
0.00
0 ppm
100 ppm
200 ppm
300 ppm
ppm of Zinc

T-test Analysis

T-test: Height Data

df = 9; α of 0.05; t = 1.833 for significance

T-Test: Height: Control vs. 100 ppm	0.541
T-Test: Height: Control vs. 200 ppm	0.315
T-Test: Height: Control vs. 300 ppm	1.108
T-Test: Height: 100 vs. 300 ppm	1.689
T-Test: Height: 200 vs. 300 ppm	1.432

T-test: Chlorophyll Content Data

df = 9; α of 0.05; t = 1.833 for significance

T-Test: Absorbance: Control vs. 100 ppm	25.28
T-Test: Absorbance: Control vs. 200 ppm	22.304
T-Test: Absorbance: Control vs. 300 ppm	18.76
T-Test: Absorbance: 100 vs. 300 ppm	27.166
T-Test: Absorbance: 200 vs. 300 ppm	11

Conclusion

Conclusion

Based on the results of the t-tests, it can be concluded that there may be an impact on chlorophyll content in leaves of black eyed peas when zinc is added to the soil, but there is no statistically significant impact, whether positive or negative, on adding zinc to the soil on the height of black eyed peas.

Discussion, Recommendations for Future Research

Discussion

- It was originally intended for all ten seeds to be planted in a single container.
- Some inconsistencies were observed in the data that could have influenced the conclusions made in this experiment.

Discussion

- Perhaps there was no statistically significant difference in the heights of the plants because of the zinc homeostasis mechanisms in plants.
- Something interesting, though, was that one plant that was treated with 300 ppm of added zinc in the soil exhibited some symptoms of zinc toxicity:

Recommendations for Future Research

- Nutrient levels should be analyzed in future research.
- Chlorophyll content should be measured in a spectrophotometer.
- Further study should be done concerning the potential use of black eyed peas in phytoremediation campaigns.

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Any Questions?