Iron Toxicity in *Raphanus sativus*

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Introduction

Iron (Fe) is a necessary micronutrient in the growth and development of plants, and is a necessary component for the creation of chlorophyll in green leafed plants. Iron, however, is also a nutrient capable of becoming toxic in excessive quantities and can lead to problems in plant growth if left unchecked. Fertilizers with salt in them may cause an overall Ph. change in the soil over time. This can lead to greater iron retention in the soil, increasing the likelihood of iron toxicity occurring. Sandy soils were used to test the fertilizer treatments in order to remove the existing minerals found in normal soil through better drainage. *Raphanus Sativus* (European radish), a rapidly-growing taproot vegetable often cultivated in somewhat sandy soils, was used due to its ability to grow both quickly and well in sandy soils. Our lab group was interested in the various amounts of iron necessary to bring a plant into iron toxicity, and used *Raphanus Sativus* to test various amounts of Iron fertilizer and their effects on plants grown with them. Our group hypothesized that plants with double the iron of a normal plant would grow more than plants with regular or deficient iron, but less than plants with quadruple the iron, due to toxicity at high levels and deficiency at low levels.

Materials and Methods

Materials

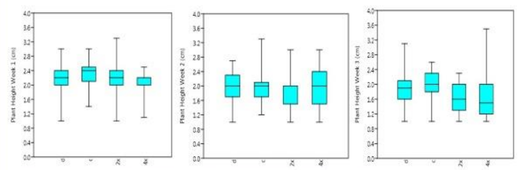
- 60 radish plants
- Normal fertilizer/Iron deficient variant fertilizer
- Double/Quadruple iron fertilizer
- Equal parts sandy/loamy soil
- PAST statistical analysis program
- Fiji Image processing program

Methods

The radishes were planted in groups of 15, labelled according to their experimental group, and germinated in a non-fertilized sand-soil mixture. After all plants had germinated, 10 mL of each corresponding fertilizer was added to each plant. In the following weeks, the leaf height, number of leaves, and various qualitative notes were taken. After the third week, each plant was bisected at the root, and each group had its total mass weighed. The leaves were collected and processed for coloration using Fiji imaging after the group masses were taken.

Results

Our group used PAST for statistical analysis, and found overall plant height, leaf number, and total group biomass. Nothing significant appeared to have occurred, with the closest two p-values coming from T-wise ANOVA tests between the week 3 leaf numbers for the 2x treatment group and the 4x treatment group, with a p-value of 0.08778, and the week 3 leaf height between the control group and the 2x treatment group, with a p-value of 0.07894.



Biomass of Plant Groups			
Deficient Iron	Control Iron	2x Iron	4x Iron
0.619 g	0.598g	0.659g	0.716

Above are weeks 1, 2, and 3 plant height in cm for all treatment groups, ordered left to right as Deficient Iron, Control Iron, 2x Iron, and 4x Iron; after testing using PAST to check for significance, nothing conclusive could be found at any stage of testing.

Fig 1. Side view of Raphanus sativus after 3 weeks of growth post fertilizer treatment; From left to right : 4x Iron, 2x Iron, Control , and Iron Deficient

Fig 2. Top-down view of Raphanus sativus; The yellow-red leaves may be signs of an excess of the enzyme ferritin in the leaves, an iron storage enzyme made in response to the increased amounts of iron in the soil.

Conclusions

Our data shows no significant correlation between the increased amounts of Iron in the fertilizer treatments and the plant group's overall growth or development, leading us to find our hypothesis unsupported. However, various qualitative changes were noticed between the individual groups, as leaf coloration and condition seemed to change radically across each group. The deficient Iron group showed signs of Iron deficiency in the form of chlorosis, and while the other groups showed signs of chlorosis, they showed signs of other nutrient based stress responses as well. The 2x and 4x Iron groups had bronzing leaves in accordance with signs of Iron toxicity, but also appeared to be showing signs of iron deficiency as well. We believe this to actually be a manganese deficiency, as the signs are similar to iron deficiency, and as manganese and iron compete for space inside a plant, a higher amount of Iron would inevitably lead to a lower amount of manganese in the plant.

Fig 3., right- The leaves of the 4x Iron group spread out on paper; The leaves of the group showed a variety of , presumably, nutrient effects on leaf coloration, ranging from iron toxicity in the redder leaves, to magnesium deficiency in the burnt looking leaves.

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Citations

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