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**The Effect of Nitrogen Soil Concentration on Leaf Fluorescence in Zea Mays**

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### Abstract

Macronutrients in the soil are essential to the growth and development of a plant. One of the most important nutrients to a plant’s growth is nitrogen. Nitrogen has been directly correlated to photosynthetic output in various studies and this relationship is the subject of this experiment. Since nitrogen has an effect on photosynthetic rate, there should be a correlation between nitrogen and fluorescence — a form of energy dissipation. This study attempted to show that nitrogen concentration in the soil is inversely proportional to fluorescence of the plant because the more nitrogen in the soil, the more energy should be used for photosynthesis rather than energy dissipation. *Zea mays* was chosen as the species of study because of its rapid growth rate and economical value to society. Hoagland’s solution was used as a baseline for the amount of nitrogen utilized by a plant in a naturally occurring setting. Distinct groups were marked on the baseline solution as the normal concentration of nitrogen. Then, two other groups were set up — one with half the concentration and another with double the concentration. Using a pulse-modulated Fluorometer, fluorescence was obtained from the plants in each of the groups under normal light, as well as under light stress. In addition, both dark-adapted and light-adapted fluorescence were measured. The results revealed that, under both normal light and light stress, light-adapted fluorescence was significantly different between our three groups. This would suggest that under highly stressful conditions, nitrogen is helpful in utilizing more energy for photosynthesis and energy dissipation is minimized.

### Discussion

The purpose of this experiment was to identify the relationship between nitrogen concentration and fluorescence. The results did not support the experimental hypothesis that nitrogen is inversely related to photosynthesis. As a result of the nitrogen concentration increase, there is more nitrogen available to create enzymes such as RuBISCO and pigments such as chlorophyll. Nitrogen concentration is found to affect the chlorophyll content in a leaf, which is the main pigment in chloroplasts responsible for intercepting light to drive photosynthesis (Mauseth, 2009). The more RuBISCO and chlorophyll, the more light energy can be absorbed, the more carbon dioxide can be fixed thereby increasing photosynthetic rate and decreasing energy dissipation such as fluorescence. In dark-adapted fluorescence, there was no difference in fluorescence values, thereby showing similar photosynthetic rates. This phenomenon shows the effect of nitrogen is very minimal in the dark reaction by not affecting the activity of RuBISCO. However, light adapted fluorescence revealed a significant difference in the experimental groups. This could possibly be attributed to the necessity of nitrogen in the synthesis of chlorophyll molecules. This suggests that since chlorophyll is a vital pigment in harvesting light for photosynthesis, the excess of nitrogen builds up more chlorophyll molecules that enable plants to utilize more light energy for photosynthesis. The results showed that fluorescence decreased as nitrogen increased in the light-adapted stage, showing a potential correlation between nitrogen concentration and chlorophyll synthesis.

### Conclusion

In this study, nitrogen was found to potentially contribute to the synthesis of chlorophyll molecules. The reason light-adapted fluorescence was lower than dark-adapted fluorescence is due to influx of nitrogen causing chlorophyll anabolism. This chlorophyll build up increases photosynthetic rate which in turn decreases fluorescence as a form of energy dissipation, as stated in the hypothesis. Possible future study would be to find the direct correlation between nitrogen and chlorophyll in relation to other forms of energy dissipation.

### Materials and Methods

This experiment is going to test the fluorescence of the monocot *Zea mays* with different levels of nitrogen in the soil. We will have eighteen monosots for each concentration of nitrogen. The solutions were based on the nitrogen compounds found in Hoagland’s parameter for the nutrient solution that outlines normal concentrations of minerals in a plant. The two compounds responsible for the nitrogen content in Hoagland’s solution are ammonium phosphate, (NH₄)₂PO₄, and calcium nitrate, Ca(NO₃)₂·4H₂O. Two stocks of 5.75g (NH₄)₂PO₄ and 11.80g Ca(NO₃)₂·4H₂O in 50 mL of water were marked for each compound, respectively. From the stock solutions, a solution with the normal amount of nitrogen was made by adding 4 mL of the stock hydrated Calcium nitrate solution and 2mL of the ammonium phosphate stock solution at a liter of water. For the solution with twice the amount of nitrogen, 8 mL of the hydrated calcium nitrate stock solution and 4mL of the ammonium phosphate stock solution was added to a liter of water. These solutions were added to the plants at the beginning of the experiment. For the remainder of the experiment only water was added to ensure survival of the plant. After 2 weeks of growth, each plant was tested using the pulse-modulated fluorometer to measure fluorescence from a single leaf of the plant. Both dark-adapted and light-adapted fluorescence was measured. The plants were placed under a high intensity lamp after being measured under normal light, so that fluorescence can be measured under light stress.

### Data/Results

**Figure 1. Dark-adapted fluorescence measured under normal light. No significant difference between groups were observed.**

**Figure 2. Light-adapted fluorescence measured under normal light conditions. There was a significant difference observed between the means of the groups.**

**Figure 3. Dark-adapted fluorescence measured under light stress. No significant difference between groups were observed.**

**Figure 4. Light-adapted fluorescence measured under light stress. There was a significant difference in the means between the groups.**

Measurements of fluorescence were taken to observe how nitrogen concentration in the soil affected the light reradiated from a leaf. Measurements taken when Photosystem II was rested (dark-adapted, Fv/Fm) had no significant differences in the three experimental groups as per a one-way ANOVA test (P=0.227, P=0.354). The mean of the different groups revealed no significant differences as shown by Figures 1 and 3. However, the analysis of light-adapted fluorescence (Fv’/Fm’) with a one-way ANOVA test reveals there is a significant difference between the nitrogen concentrations (P=0.012, P=0.043). Figures 2 and 4 show the differences in the means for each group.

### Literature Cited


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