PLS100BL : Lab 4
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Plant Cell Expansion in Response to Auxin and Water Potential

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Abstract

This experiment documents the effects of incremental water potential treatments on one centimeter long hypocotyl segments of etiolated sunflower seedlings with and without the presence of auxin. The resulting data indicates that growth responses to increased water potential were inverted; that is, increases in turgor pressure produced linearly correlated increases in growth. The treatments with auxin produced similar associations with further proportional increase in growth. The experiment was successful in its attempt to demonstrate the role of water potential and auxin in cell expansion.

Introduction and Background

The rate of nutrition uptake by plants is often directly related to growth and yield. Maximizing uptake can be vital to increasing production and is, therefore, of interest to agriculture at large. Factors that can dictate change in this uptake and the subsequent metabolic alterations are environmental and endogenous to the plant. A plant's internal water potential is a primary factor in its ability to uptake nutrients. Inside of the cell, water potential is comprised of two factors: pressure potential and solute potential. Outside of the cell, water potential fluctuates with temperature and solute potential. At ideal water potential conditions, growth and yield increase is further modulated by the presence of the plant hormone auxin. By controlling environmental factors and varying solute potential, this investigation aims to determine responsive growth in seedlings with respect to turgor pressure potential within the cell and the presence of auxin.

Methods

The experiment utilized a continuous span of 8 different water potential treatments prepared with potassium phosphate buffer (pH 6.0), 20 mM sucrose, and mannitol. Of these 8, 4 were prepared with auxin and 4 were lacking auxin. The experiment calls for solutions at -0.1, -0.3, -0.5 and -0.7 MPa, which were verified with a vapor pressure osmometer. The osmometer verified water potential measurements were used in the final analysis. 240 count of 1 cm

seedling segments were cut and distributed among the 8 treatments in petri dishes. After one week of exposure to the solutions, the segments were measured again for growth and the averages across 30 segments per treatment were calculated and reported.

Results

Vapor Pressure Osmometer Verification

The plant tissue and the prepared solutions were tested by a vapor pressure osmometer that produced measurements of water potential and solute pressure respectively to be used for determining turgor pressure potential.

Osmotic Pressure Tests

Osmotic values (m os moles/kg)									
		Solution ψ_s							
		5	6	7	8	1	2	3	4
Group	Ground Tissue ψ	-NAA/ 0.1MPa	-NAA/ 0.3MPa	-NAA/ 0.5MPa	-NAA/ 0.7MPa	+NAA/ 0.1MPa	+NAA/ 0.3MPa	+NAA/ 0.5MPa	+NAA/ 0.7MPa
1	457	57	136	213	303	56	136	214	300
2	400					75	145	220	310
3	418	40	131	223	306				
4	416								
5	329								
6	463								
Averages	413.8333	48.5	133.5	218	304.5	65.5	140.5	217	305
ψ = -RT c	-1.0263	-0.1202	-0.3310	-0.5406	-0.7551	-0.1624	-0.3484	-0.53816	-0.7564

Figure 1. This table presents the water potential recorded from mortar-and-pestle ground samples as it represents internal water potential within the cells. The treatment solutions were similarly tested to provide more accurate measurements of solute potential and, ultimately, more accurate delinations for turgor pressure in the treatments.

Growth and Yield Response with Treatment

Growth Data Table

Growth Measurements (cm)									
Solution		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Averages	ψp = ψ - ψs
1	+NAA/ 0.1MPa	0.48	0.5	0.24	0.5	0.28	0.44	0.392	0.8638667
2	+NAA/ 0.3MPa	0.26	0.02	0.16	0.18	0.2	0.16	0.144	0.6778667
3	+NAA/ 0.5MPa	0.06	0.14	0.08	0.1	0.06	0.06	0.088	0.4881467
4	+NAA/ 0.7MPa	-0.08	0.14	0	0	0	0	0.028	0.2699067
5	-NAA/ 0.1MPa	0.06	0.32	0.424	0.1	0.22	0.2	0.2528	0.9060267
6	-NAA/ 0.3MPa	0.14	0.16	0.01	0.02	0.14	0.06	0.078	0.6952267
7	-NAA/ 0.5MPa	-0.02	0.04	0.06	0.02	0.06	0	0.036	0.4856667
8	-NAA/ 0.7MPa	-0.08	-0.01	0.02	-0.02	0	0	-0.002	0.2711467

Figure 2. Growth measurement data in centimeters from each petri dish for each treatment for each group's replicant was recorded in this table. Also included are the averages for each treatments and a column for the empirically derived turgor pressure calculations.

Growth by Turgor Potential Measurements

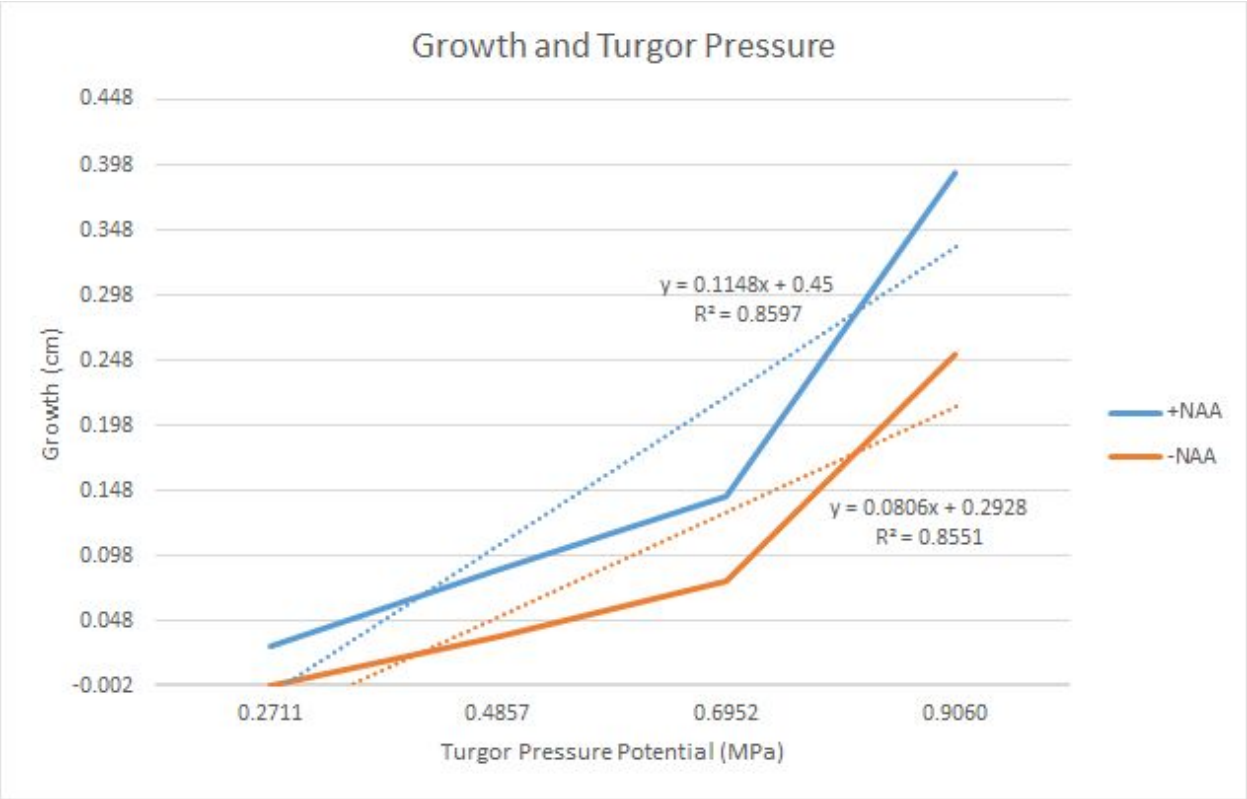

Figure 3. This graph is a display of the growth data averages and turgor pressures values from the last two columns in Figure 2. The two lines represent auxin presence (blue) and the lack of auxin presence (orange).

Discussion

The linear regression formula for the auxin treatments produced a growth rate of approximately 0.1148 cm per MPa while the treatments with auxin absent produced an approximate rate of .0806 cm per MPa. This higher growth rate observed in the auxin treatments demonstrates that auxin allows for greater growth per MPa and confirms our preexisting knowledge about the stem elongation and cell expansive properties of auxin.

Conclusion

Cell expansion is the essential property of plant physiology that allows the human race to benefit from the yields that crop plants are cultured to produce. Nutrition uptake balances in the internal and external properties of the plant allow for greater and greater amounts of nutrition uptake as the plant matures and grows. This experiment revealed that this cell expansion is

associated with factors such as turgor pressure within the cell, hormonal controls within the plant, and solute pressure potential within the nutrients in the environment. The optimal level of growth can be achieved through empirical testing of each of these factors. Information indicating productivity increase at the cellular level could result in substantially greater yields for any crop production operation in need of more yield.