Analysis of Plant Height across Two Processes

Summary

An analysis of the height and consistency of twelve plants across two processes through time reveals that the six plants under the Aquaponics system grew taller and more consistently than the six plants under the traditional Soil system. Even after qualitatively accounting for known benefits of higher wattage, the Aquaponics system indicates potentially better results. Further analysis on future plants will control for wattage and other factors such as light, water, and specific nutrients to further understand differences between the two processes.

Analysis

Figure 1 plots the height of the twelve plants under the two systems (Aquaponics and Soil) across five weeks. The dots indicate the individual plants while the connector line plots the mean (average) height.

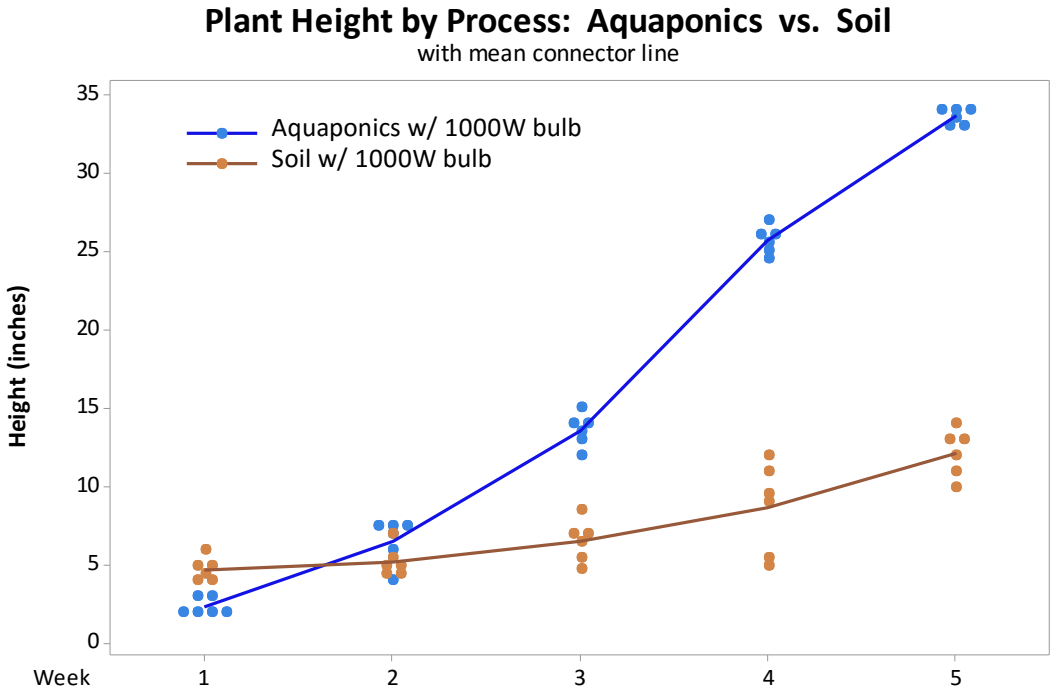

Figure 1. Plant height by process for twelve plants across time.

Visually obvious, the plants using the Aquaponics process produced far taller plants with lower associated variation even despite having started out shorter in Week 1. The analysis explores both this differential in height as well as the tighter consistency.

Analysis of Actual Height

A General Linear Model using Process, Week, and the interaction of the two shows as follows.[1]

Factor coding (1, 0)

Factor	Type	Levels	Values
Process	Fixed	2	Aqua, Soil
Week	Fixed	5	1, 2, 3, 4, 5

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Process	1	17.52	17.521	9.87	0.003
Week	4	220.08	55.019	30.99	0.000
Process*Week	4	1233.15	308.286	173.66	0.000
Error	50	88.76	1.775		
Total	**59**	**5590.10**			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
1.33237	98.41%	98.13%	97.71%

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	4.750	0.544	8.73	0.000	
Process					
Aqua	-2.417	0.769	-3.14	0.003	5.00
Week					
2	0.500	0.769	0.65	0.519	3.20
3	1.792	0.769	2.33	0.024	3.20
4	3.917	0.769	5.09	0.000	3.20
5	7.417	0.769	9.64	0.000	3.20
Process*Week					
Aqua 2	3.75	1.09	3.45	0.001	3.60
Aqua 3	9.46	1.09	8.69	0.000	3.60
Aqua 4	19.42	1.09	17.85	0.000	3.60
Aqua 5	23.83	1.09	21.91	0.000	3.60

This model shows an adjusted R^2 of over 98%, indicating an extremely tight fit. More importantly, the interaction term Process*Week shows statistically significant positive and increasing coefficients which lend evidence that across time, the Aquaponics process outperforms the standard Soil process, in terms of plant height.

Future models will control for light wattage, water, and other factors known to affect growth regardless of process used. Accounting for these additional factors will fine-tune the understanding of how the Aquaponics process improves upon the Soil process.

[1] MiniTab v17 served as the statistical package for the entirety of this analysis.

Analysis of Consistency of Height

Comparing the coefficients of variation by week between each process allows us to understand the variance among the plants after taking into account the differential in height. First, we standardize the heights of the plants across weeks by dividing individual plants' heights by the average Week 1 height for each process. Next, we calculate the coefficient of variation to control for the plants' performance using the Aquaponics system. Those values appear as follows.

Process	Week	Coefficient of Variation
Aquaponics	2	21.2
Aquaponics	3	7.5
Aquaponics	4	3.4
Aquaponics	5	1.5
Soil	2	17.8
Soil	3	20.0
Soil	4	33.0
Soil	5	12.1

One can directly compare across weeks and across processes because they represent dimensionless values. For instance, the coefficients of variations ("CoV") decline across time for the Aquaponics system indicating that the plants reach a very consistent height even after starting out more heterogeneous. More importantly, the CoVs appear far lower for the Aquaponics system for weeks 3 through 5 indicating that after controlling for the opportunity for variance to show far higher for the Aquaponics plants (because of far taller plants than those under the Soil process), the Aquaponics plants grew quite consistently. Such low variability proves desirable especially when attempting to improve systemic performance by introducing variation in nutrients, for example. Isolating the effects of such changes should prove easier when beginning with a stable underlying system in the first place.