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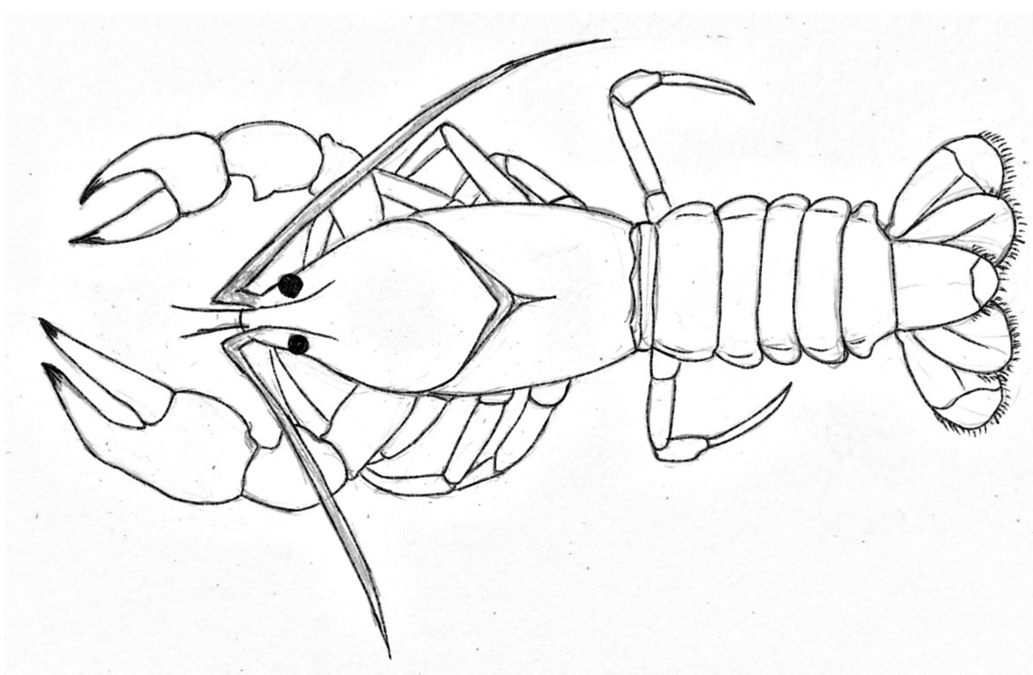

Juniata Journal of Ecology

An annual journal of Juniata College undergraduate, graduate, and alumni research in ecology and environmental science

Editors:

PURPOSE

The Juniata Journal of Ecology (formerly Journal of Ecological Research from 1998 - 2024) launched in 1998 as a lab component of Dr. Glazier's General Ecology course to expose Juniata students to the publication process and to archive past research projects. In 2025, we modernized its internet presence for free open-access and expanded the content beyond the General Ecology course to include any ecological research from Juniata undergraduate and graduate students and alumni. The journal focuses on research from the Mid-Atlantic and Appalachian regions, but also includes research from outside our region. The open-access policy makes the journal free for both authors and readers and increases accessibility. Journal operations are managed by a team of students with faculty mentors overseeing the project at Juniata College.

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Cover illustration: Common Crayfish, *Cambarus bartonii*

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DIFFERENT LIGHT TYPES AND THEIR EFFECT ON WISCONSIN FAST PLANT GROWTH RATE

By Dan McCauley, Caiden Alexander, Logan Douglas, and Dawson Booher

ABSTRACT

In this lab, we looked at how the growth rate of Wisconsin Fast Plants would change in different types of artificial light environments with our experimental groups being incandescent, fluorescent, and LED lights. The reason we chose to study this is to better understand the ideal light environment for use in plant cultivation indoors. This lab took place over a 2-week period wherein we measured the height in cm of the tallest plant in each pot every other day, logging it and looked for a trend after calculating growth rates. The data we collected shows that LED lights have a positive effect on growth rate for Wisconsin Fast Plant and displays the best effect from among these other common artificial light sources (fluorescent and incandescent).

Keywords: Growth Rate, LED, Fluorescent, Incandescent, Wisconsin fast plant

INTRODUCTION

Fast plants were first developed into the plant they are today by Professor Emeritus Paul H. Williams at the University of Wisconsin-Madison through artificial selection. Dr Williams bred rapid cycling Field mustard *(Brassica rapa)* initially as a tool for his research into improving disease resistance of cruciferous plants, such as broccoli, cabbage, mustard, radish, and other similar species. Dr. Williams then began breeding *Brassica rapa* and six related species from the Cruciferae family for shorter life cycles, with the result being what we know as Wisconsin Fast Plants. These plants typically take around 14 days (about 2 weeks) to start flowering, hence the name “Fast Plants” which cannot be solely attributed to Dr. Williams as many successors built off his work to give it the growth rate we have today. These fast plants are accustomed to growing very well in small indoor spaces with extraordinarily little soil and unnatural lighting as they rapidly mature with no dormancy in the seed state. The Wisconsin Fast Track Plant’s official website mentions that they are easy to grow due to their “Ability to grow under continuous fluorescent lighting in standard potting mix” which we have decided to pursue and test as to whether this light source is the optimal artificial source for fast plant growth.

The lights we are choosing to test for this are incandescent lights, fluorescent lights, and LED lights. Based on our hypothesis, these 3 distinct types of artificial lighting should grow the plants at different rates as they offer several variations in the types of light they emit. Furthermore, LED’s can be designed to give off very precise wavelengths of light (converts energy to light with high efficiency) whereas fluorescent bulbs merely attempt to replicate that natural light with phosphors and incandescent lighting uses heat to generate light.

Our hypothesis is that the Wisconsin Fast Plants will stay relatively the same height as the others but have a slight favor towards the LED light bulbs over incandescent and fluorescent due to the precise wavelengths of light emitted and the efficiency of energy conversion to light that the LED light bulbs will give off which surpasses that of its counterparts. We did not think Incandescent light would be the best because it is natural sunlight and does not give off as high of emitted light as the LED or Fluorescent light do, and you never know how much the sun is going to shine that day and the plants will need the sunlight to help it grow better.

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FIELD SITE

The field site chosen for our LED light experimental group was a side room in Brumbach Academic Center (BAC) that was part of our lab classroom for this class. The other site for our plants was another side room across the hall and two doors down from our lab that was in BAC which held both our fluorescent lights and our incandescent light groups. Although they were in the same room, they were put in two separate holding areas where they would not affect each other that were both decommissioned temperature control units as seen below.

LED Site

Fluorescent Site

Incandescent Site

METHODS AND MATERIALS

We will be doing experiments with 100 Wisconsin fast plant seeds by first separating them into groups of 8 seeds, then distributing them into 12 plastic pots with adequate potting soil. We will then place 4 pots into each experimental testing site, with the sites being the incandescent, LED, and fluorescent light control environments. These control environments will be one in a dark room and two in no longer used temperature control units as they were the easiest places we could find to isolate the factor of light. This controlled light environment will allow us to measure accurately our specific dependent factors with a lower variability in our results. We will then move to consistently monitoring the plants once every other day, initially checking them every day for the first three days to determine how often we water them. On each checkup, we will also log the heights of the plants as plant height is the dependent factor we chose and use a repeated measures Anova test with every single day as the measure and grouping as different light categories.

DATA

Fig 1

Day 1		
LED	Fluorescent	Incandescent
0.9	2.1	2.3
1.7	3.1	3.1
2.1	3.2	3.3
3.9	5.1	4.4

Day 2

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LED	Fluorescent	Incandescent
3.4	4.8	5.7
3.1	5.1	4.9
3.9	5.6	5.7
4.8	7	3.7

Day 3		
LED	Fluorescent	Incandescent
4.4	6.2	6.9
3.4	5.7	5.6
5.3	6.7	5.8
5.2	6.1	4.7

Day 4		
LED	Fluorescent	Incandescent
4.9	5	7.3
4.5	6.2	6.5
5.7	7.1	7
6.1	6.5	4.7

Day 5		
LED	Fluorescent	Incandescent
5	5.2	6.5
5.2	6.3	7
6	7.2	6.1
7.2	4.3	4

Day 6		
LED	Fluorescent	Incandescent
5.4	5.5	4.5
6.4	6.9	6.5
6.5	8	7
8.1	4.5	6.1

Day 7		
LED	Fluorescent	Iridescent
6.2	7	4.2
7.7	5.5	6.6
7.6	6.5	7.3
9.1	5.4	6.2

Fig 2

light type	Group	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
LED1	1	0.9	3.4	4.4	4.9	5	5.4	6.2
LED2	1	1.7	3.1	3.4	4.5	5.2	6.4	7.7
LED3	1	2.1	3.9	5.3	5.7	6	6.5	7.6
LED4	1	3.9	4.8	5.2	6.1	7.2	8.1	9.1
Flourescent 1	2	2.1	4.8	6.2	5	5.2	5.5	7
Flourescent 2	2	3.1	5.1	5.7	6.2	6.3	6.9	5.5
Flourescent 3	2	3.2	5.6	6.7	7.1	7.2	8	6.5

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Flourescent 4	2	5.1	7	6.1	6.5	4.3	4.5	5.4
Incandescent 1	3	2.3	5.7	6.9	7.3	6.5	4.5	4.2
Incandescent 2	3	3.1	4.9	5.6	6.5	7	6.5	6.6
Incandescent 3	3	3.3	5.7	5.8	7	6.1	7	7.3
Incandescent 4	3	4.4	3.7	4.7	4.7	4	6.1	6.2

Fig 3

Descriptives

RM Factor 1	Group	N	Mean	SD	SE	Coefficient of variation
Day 1	1	4	2.150	1.269	0.634	0.590
	2	4	3.375	1.253	0.626	0.371
	3	4	3.275	0.866	0.433	0.264
Day 2	1	4	3.800	0.744	0.372	0.196
	2	4	5.625	0.974	0.487	0.173
	3	4	5.000	0.945	0.473	0.189
Day 3	1	4	4.575	0.881	0.440	0.193
	2	4	6.175	0.411	0.206	0.067
	3	4	5.750	0.904	0.452	0.157
Day 4	1	4	5.300	0.730	0.365	0.138
	2	4	6.200	0.883	0.442	0.142
	3	4	6.375	1.164	0.582	0.183
Day 5	1	4	5.850	0.998	0.499	0.171
	2	4	5.750	1.266	0.633	0.220
	3	4	5.900	1.319	0.660	0.224
Day 6	1	4	6.600	1.117	0.558	0.169
	2	4	6.225	1.539	0.770	0.247
	3	4	6.025	1.081	0.541	0.179
Day 7	1	4	7.650	1.185	0.592	0.155
	2	4	6.100	0.779	0.389	0.128
	3	4	6.075	1.330	0.665	0.219

Fig 4

Marginal Means

Marginal Means - Group

		95% CI for Mean Difference		
Group	Marginal Mean	Lower	Upper	SE
1	5.132	4.373	5.892	0.336
2	5.636	4.876	6.395	0.336
3	5.486	4.726	6.245	0.336

Fig 5

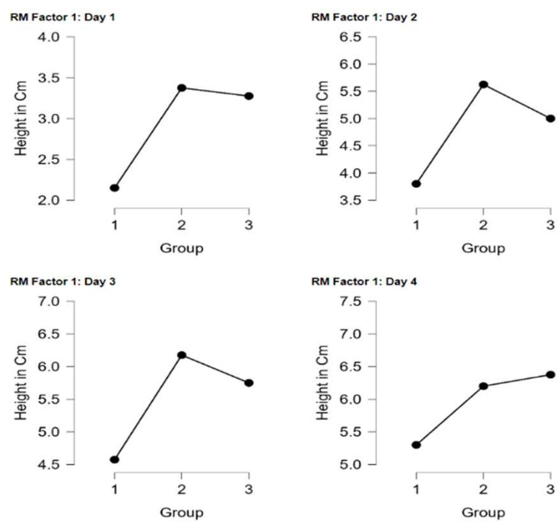

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Fig 6

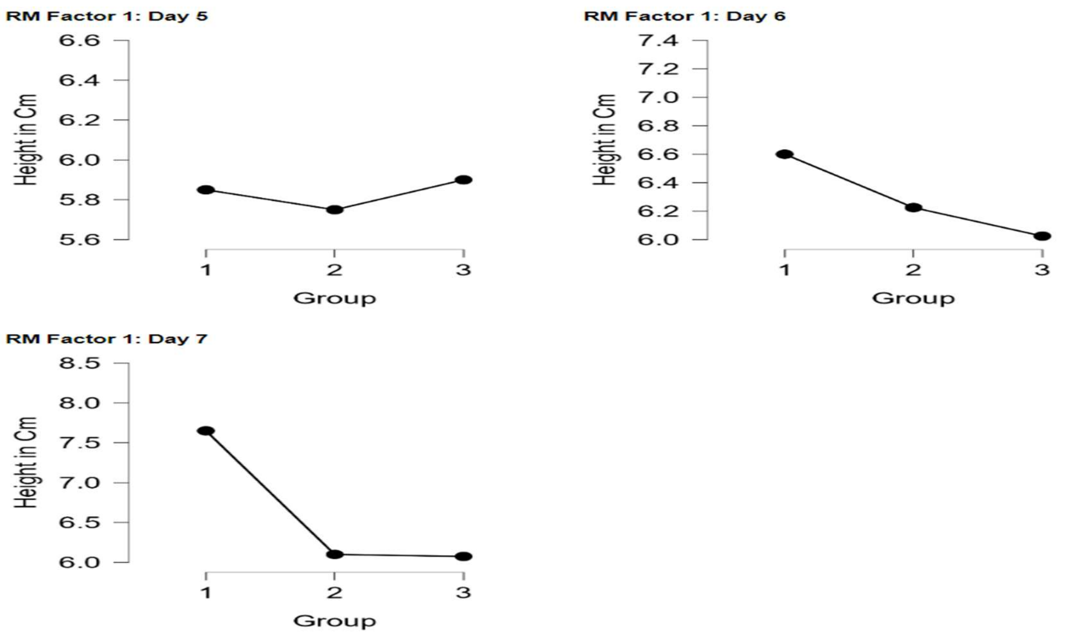

Fig 7

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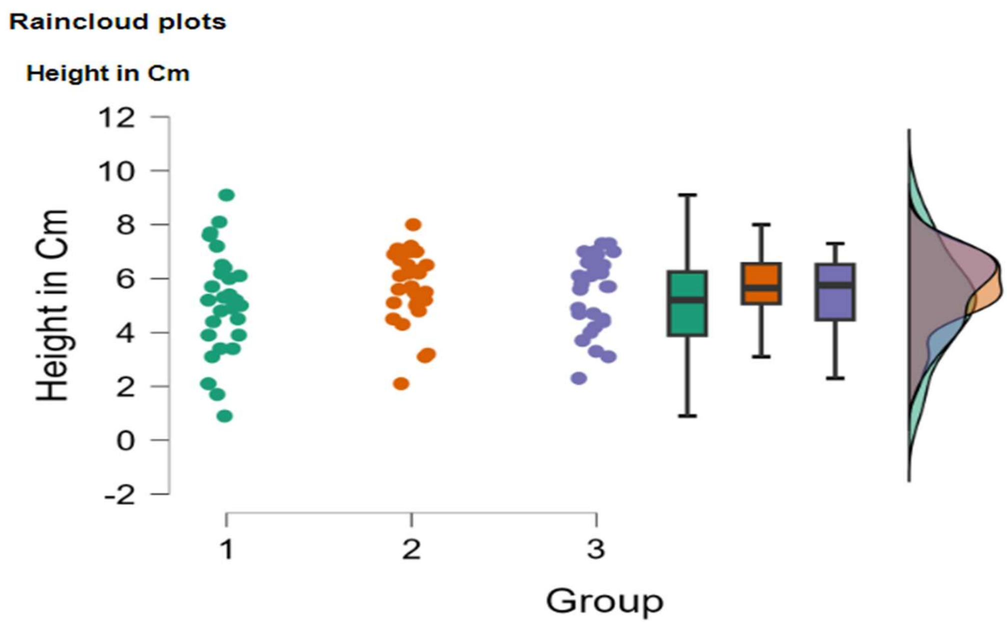

RESULTS

In the data, it is set up as group 1 is LED, group 2 is fluorescent, and group 3 is incandescent. We found that when the data was not grouped together, they were not incredibly significant with a p-value less than 0.001 but, when we grouped them that had a significant increase in their p-value as it rose to 0.573 which would display a high correlation between the 3 different types of light. This can be seen when looking at the graphs and seeing the differences between the 3 groups over the course of all the days. On (Fig 5) it shows that In Day 1 it shows LED lights (1) are lagging with a mean of 2.150 cm (about 0.85 in). behind as fluorescent (2) has an early lead with a mean of 3.375 cm (about 1.33 in). with incandescent (3) closely behind with a mean of 3.275 cm (about 1.29 in). In Day 2, it shows highly comparable results as LED is slowly growing with a mean of 3.800 cm (about 1.5 in). as the fluorescent light reaches a height of 5.625 cm (about 2.21 in). and incandescent lights slowly take second with a mean height of 5.000 cm (about 1.97 in). In Day 3 it shows remarkably comparable results as the last two days as LED is slowly growing with a mean height of 4.575, the florescent light has a mean height of 6.175 cm (about 2.43 in), and incandescent lights take off with a mean height of 5.750 cm (about 2.26 in). In Day 4 the data shows that LEDs are still behind with a mean height of 5.300 cm (about 2.09 in). while fluorescent had a height of 6.200 Cm. and iridescent flip to make iridescent the tallest at a mean of 6.375 cm (about 2.51 in). On (Fig 6) it shows that In Day 5 it shows LEDs taking a large jump to 5.850 cm (about 2.3 in). while pushing fluorescent to the lowest with 5.750 cm (about 2.26 in). and incandescent keeping the lead with 5.900 cm (about 2.32 in) on average. In Day 6 it shows LEDs make a large jump again as they lead with a mean of 6.600 cm (about 2.6 in). fluorescent slows down with a mean of 6.225 cm (about 2.45 in). and incandescent takes last with a mean of 6.025 cm (about 2.37 in). In Day 7 it shows that LEDs are still charging the lead heavily with 7.650 cm (about 3.01 in). and both florescent and incandescent leveling with a slight edge to fluorescent with a mean of 6.100 cm (about 2.4 in) and incandescent having 6.075 cm (about 2.39 in). Also, in Fig 7 it shows us the LEDs (1) are the tallest and the most like a bell curve to show it had normal growth patterns. Florescent has a slight right skew too as its growth slowed as it reached Day 7 with the same effect happening to incandescent as it shows a right skew.

DISCUSSION

During our experiment with growing the Wisconsin fast plants, there were different variables that could have played different roles in the growth rate. One factor that may have stunted growth during this study was having a 14-hour period wherein the power shut off in the labs due to a storm which ravaged our area. This may have caused problems with the plants' growth rate, slowing them as they were deprived of light for about 12 hours before us checking them. The lack of power also could have created a more humid environment due to lack of proper airflow, dehydrating the plants on top of the inhibition of photosynthesis. Another factor is the constant temperature for the plants could have slowed or sped up the growth rate as they were not put in rooms where the temperature would stay at a constant.

When looking at our results we can see the results of the growth rates. Looking closer at figures 5 and 6 we see how the height changes in the fast plants with the different lights. Group 1 is the LED, Group 2 is the fluorescent, and Group 3 is the incandescent. The main result of our experiment was that LED light was the best option to have the fastest plants grow the most. An interesting finding was that LED was the worst for the first four days of growth, but then it skyrocketed ahead after day 5. A factor that could explain this is the heat generated by the lights. In the beginning days, the heat generated from each of the light sources were likely around the same. However, the longer that they are on the hotter they can get. LED lights compared to fluorescent and incandescent lights do not get as hot. LED temperature rises considerably less than any other form of artificial light. Since around day 5 is when the fastest plants started to grow much more than the others in group 1, we can infer that the heat generated from group 2's and 3's lights became too hot which would affect the growth rate of the plants.

Keeping in mind the power outage, this whole process could have been delayed and we could have possibly seen a rise in growth in group 1's plants sooner. We can consider this a huge factor because the plant's growth rate was the smallest in group 3, the incandescent light source. It is known that about 90% of the energy used for these lights is wasted to generate heat which could have become too much for the fast plants, which stunted their growth. The same process seemed to happen with the fluorescent lights as well, just not as intense. LED lights do not waste as much energy, giving off heat, which goes to show in the results how the plants in that group seemed to skyrocket compared to the others.

Another interesting thing from our data was the standard deviation which ranged from 1.330 to 0.779. This showed that the fast plants from all the groups on the last day had grown remarkably similar, which supports the validity of our findings. Seeing that all the fast plants in each group of light varied very closely together shows that the effects measured are constant and the fast plants react consistently to the variables. This finding from the results highlighted that the source of light does in fact play a vital role in the growth rate of the plants.

ACKNOWLEDGMENTS

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LITURATURE CITED

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