The Effects of Gibberellic Acid on Wild-Type and Rosette Plants

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Introduction

In this lab, we studied the development and growth of the plant *Brassica rapa* (RCBr), which is a rapid-cycling plant that facilitates accelerated plant breeding and has an average life cycle of approximately 35 days. Two types of RCBr plants were used for this lab, the rosette phenotype and the normal wild type phenotype. The difference between these two phenotypes is that the normal wild type is the naturally occurring form of RCBr, and the rosette is the mutated form.

The development of such a plant is dependent on the interplay of numerous internal and external factors. Some of the major internal factors that effect the development of a plant are the hormones present. Hormones are organic substances produced in one tissue and transported to another tissue, where their presence results in a physiological response. These hormones are active in very small amounts.

According to the *Science and Plants for Schools* on-line article "Phenotypic expression and gibberellic acid in rapid-cycling brassicas," the rosette phenotype seems to be under the influence of a single Mendelian recessive gene. According to the *Biosynth Chemistry and Biology* on-line article "Plant Hormones and Growth Regulators," gibberellic acid is a natural plant hormone that "promote[s] flowering, stem elongation and break[s] dormancy of seeds." It has been shown that the rosette (*ros/ros*) mutants contain up to ten times less gibberellic acid than the normal wild type plants (*ROS/ROS*). This lack of GA then decreases the elongation of the plant's internodes in the rosette phenotype, causing the leaves to lie flat against the soil.

As a result, we used the hormone gibberellic acid to study the effects of a hormone on plant growth for this lab. Therefore, our hypothesis is that we believe applying gibberellic acid of a 100% concentration to both a rosette and wild type plant with would increase the stem elongation and speed up the growth of both phenotypes of RCBr plants, compared to applying simply water to both phenotypes. However, we expect there to be the most drastic growth in the rosette phenotype because it is the mutant form.

Methods

During this lab, we made our best efforts to adhere to the guidelines stated in the manual. We properly planted and watered the plants on the stated days in the "Growing Instructions," planting two quads with wild type seeds and two quads for the rosette seeds. For both phenotypes, one quad was to be used as a control, which was only exposed to a water treatment, and the other to be used as the experimental quad, which would be exposed to the GA treatment. On Day 7, we applied one drop of GA to the leaves of the plants using a Q-tip to the experimental quads and watered the control plants as well. However, we chose to change our experimental design, as we waited to add GA again until Day 14. We then continued to apply the GA for each day after that, until the final day, Day 21. Over the course of this time period, we measured the growth of the plants by scheduling out certain days over which we would each individually come into the lab outside of class. We measured (in centimeters) from the soil to the base of the leaves, in order to maintain consistency. We also took pictures on Day 18 to capture the plants in the approximate middle of their growth periods. These conclude the adjustments that were to be made throughout this experiment.

Results

After 22 days of measuring plant growth effect from applying gibberellic acid to rosette and wild-type, the results vary. The rosette control plants A-D grew to 3cm, 3.5cm, 5cm and 3cm respectively. The rosette plants that gibberellic acid was applied to grew to 3.6cm, 6.9cm, 6.8cm and 16.8cm*(see analysis for explanation) respectively. Therefore, the average plant height at the end of the 22nd day for the rosette control was 3.63cm. For the rosette with gibberellic acid, the average final plant size, excluding the extreme outlier (Plant D) was 5.77cm. Therefore, on average, the plants that received gibberellic acid resulted in a plant height that was approximately 37% higher than that of the rosette control.

After 22 days of measuring the effect of gibberellic acid on the plant growth on wild-type plant, the following plant heights resulted. For the wild-type control the plants A-D grew to 11.9cm, 16cm, 9cm and 14cm respectively. The average plant height after 22 days for the wild-type control was 12.73cm. The average height for the wild-type plants that had gibberellic acid applied to them was 11.6cm.

As are illustrated in the graphs, various plants grew to different heights at different rates, even those receiving the same treatment. The attached graphs provide a visual representation of the above listed data results. These represent the plant height at each point in time throughout this experimentation process. Refer to graphs and data sheet for in depth and visual representations of the aforementioned results.

Plant Growth Chart (in cm)

Rosette GA	Day 7	Day 9	Day 11	Day 13	Day 14	Day 18	Day 19	Day 22
A	0.7	1.3	1.4	1.4	1.7	2	2.1	2.6
B	0.3	0.7	1	1	1.2	4	4.3	6.9
C	0.6	1.1	1.3	1.2	1.8	4.5	4.8	6.8
D	1.5	2.4	4	4.1	12.8	13.8	16.1	16.8

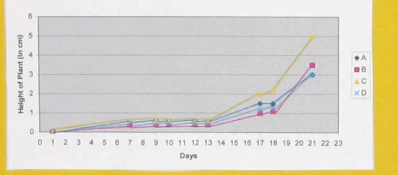
*Wildtype see

Rosette Control	Day 7	Day 9	Day 11	Day 13	Day 14	Day 18	Day 19	Day 22
A	0.5	0.6	0.6	0.6	0.6	1.5	1.6	3
B	0.4	0.4	0.4	0.4	0.4	1	1.1	3.5
C	0.6	0.6	0.6	0.6	0.6	2	2.2	5
D	0.5	0.5	0.5	0.5	0.5	1.2	1.3	3

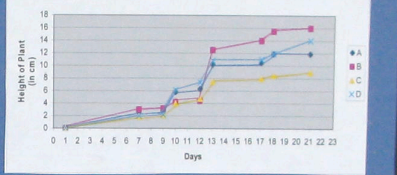
Wildtype GA	Day 7	Day 9	Day 11	Day 13	Day 14	Day 18	Day 19	Day 22
A	2.2	2.4	4	4.5	9	9.5	10.8	11
B	3	3.1	5	5.3	12.5	13.6	14.2	14.2
C	1.8	2.2	4	4.5	9	9.5	9.9	9.6
D	2.6	3.1	4.8	5.3	9	10.5	11.4	11.4

Wildtype Control	Day 7	Day 9	Day 11	Day 13	Day 14	Day 18	Day 19	Day 22
A	2.5	2.7	3.8	8.3	10.2	10.9	11.9	11.9
B	3	3.2	4.2	4.4	12.5	14	15.6	16
C	1.9	2.1	4	4.6	7.5	8	8.5	9
D	2	2.2	6.1	7.3	10.8	11	11.8	14

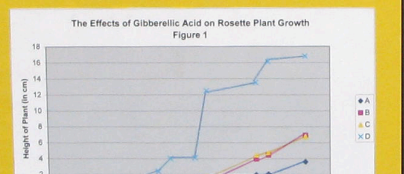
Rosette Plant Growth as Control
Figure 2



Wildtype Plant Growth as Control
Figure 3



The Effects of Gibberellic Acid on Rosette Plant Growth
Figure 1



The Effects of Gibberellic Acid on Wildtype Plant Growth
Figure 4

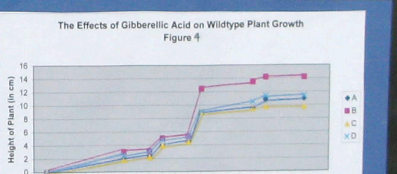


Figure 1

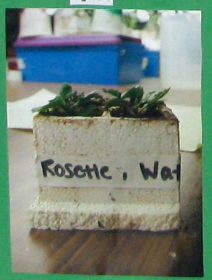


Figure 2

Figure 3

Figure 4

Conclusions

Our hypothesis that the gibberellic acid would increase the rate of growth for both the rosette and wild-type plants was not entirely supported by our results. Although the rosettes with gibberellic acid did support our hypothesis, the wild-type plants with gibberellic acid were shorter and grew slower than the wild-type plants without the gibberellic acid. What can account for this unexpected trend in the wild-type plants? As we know, gibberellic acid is a natural plant hormone that promotes flowering and stem elongation (Biosynth, 3. Apr. 2006). The rosette plant naturally has 4 to 10 times less gibberellin in its tissues as compared to the wild-type plant, therefore attributing for its dwarf size. It then makes sense that when we applied gibberellic acid to the rosette plants, they grew faster and were bigger than the controlled rosette plants. This was because there was room for increased amounts of gibberellin to increase the plants' growth. As for the wild-type plants, because they had so much more gibberellin, a maximum gibberellin concentration level may have existed; the wild-types were very likely operating at maximal levels. "Results of the wild type strain show that exposure to exogenous gibberellins had little to no effect on the growth rate." (Russel, Sunday). When there are higher levels of gibberellin than normal, the wild-type plants will automatically stop their own synthesis which is what appears to have happened according to our data.

Error Analysis

Although our results are indicative of how much gibberellic acid affects growth, this experiment was not without error. First of all, because there was more than one person measuring the plants, each person could have measured the plants differently. Although a uniform way of measurement was set as to avoid this error slight deviations may have occurred with three people present in the group.

Along these same lines, we made an error early on that we had hoped wouldn't affect the outcome of our experiment initially, but in the end quite possibly did. We began applying the gibberellic acid on Day 7 when we began measurements, but didn't continue to apply it every other day until Day 14 when we realized our mistake. This is indicative of how much the gibberellic acid affects growth. If we had added the gibberellic acid consistently right from the start, perhaps this would have given the wild-type plants with the growth hormone more time to reach heights greater than the controlled plants, although according to our research, it is more than likely that the wild-type plants reached their maximum amount of gibberellin and stop their own synthesis as mentioned above. Still, this small factor could have affected the wild-type plants' growth to some extent so we cannot rule out this error.

It was also peculiar that both the wild-type plants with gibberellic acid and without gibberellic acid both began to significantly increase around Day 14; these findings can more than likely be contributed to human error also. Perhaps gibberellic acid was accidentally applied to all plants only on Day 14 which would account for the initial significant increase in height for the control plant, but once the gibberellic acid wasn't applied again, the height eventually stopped increasing dramatically, but rather at a steady pace as opposed to the wild-type with the gibberellic acid that increased rapidly until around Day 18 and then only grew minimally from that day on.

A very obvious error that we made can be found in the graph entitled "The Effects of Gibberellic Acid on Rosette Plant Growth". The seed planted in box A exhibited growth trends comparable to a wild-type plant, rather than a rosette which is what it was supposed to be. Therefore, we believe that a wild-type seed was accidentally planted in this box, therefore attributing to its very similar growth patterns to that of a wild-type plant on gibberellic acid, rather than like the other three plants in its same quad.

A technical error in the position that each quad was placed under the lights; this could have affected both plant types' growth. They were constantly being moved around when the experimenter would come to measure them and therefore, each time perhaps one quad got more or less light or was left in an undesirable position so it didn't get the amount of light it needed to properly grow.

A strength in this experiment was the amount of plants being observed. Instead of comparing two rosette plants and two wild-type plants, we compared four plants in each of the four quads therefore giving us more opportunity for accurate results. Another strength was frequency in which we measured the plants. We kept a record of growth so as to see the progress that the plants made over a long period of time.

Overall, we learned that plant growth and development must be done extremely carefully and appropriately maintained in order to achieve the desired results for your plants. We learned that when gibberellic acid is applied to a RCBr plant properly and accurately, it indeed promotes growth and elongation in rosette plants because of the lower levels of gibberellin they contain, but for wild-type plants, too much exogenous gibberellin will in fact cause their synthesis to stop.

References

1. BIOSYNTH. "Chemistry and Biology." 2006. http://www.biosynth.com/index.asp?topic_id=103&gr=1&sc=121.
2. Russel, Sunday. Effects of Exogenous Gibberellic Acid (GA3) Application on Stem Elongation in Wild-Type and rosiea mutants of Brassica campestris. http://www.ubc.ca/~mmp/Papers/BIOChrassica.html.
3. Science and Plants for Schools. "Phenotypic expression and gibberellic acid in rapid-cycling brassicas." 2008. http://www.saps.plantsci.cam.ac.uk/records/res87.htm.