Effect of Salicylic Acid on Abiotic Stress Resistance

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Introduction

This experiment was conducted to better understand the effect of salicylic acid (SA) and stress on the Wisconsin Fast Growing Plant, *Brassica rapa*. Salicylic acid is considered a plant hormone and has been shown to play a role in plant defense when subjected to a biotic or abiotic stress. Research has shown that plants seem to release SA in response to abiotic stress, while the effect of this hormone is still disputed. Some theories include that SA is involved in the immune response of the plant, SA is a sort of messenger to warn other plants around the stressed individual of a threat, and that SA is somehow involved in water regulation to allow the plant to endure harsh conditions more easily and for a longer period of time. This experiment focused on the last theory; in order to stress the plants drought was used as an abiotic stress.

A similar experiment was conducted by Asim Kadioglu et. al. in which drought was used to stress a group of plants. Some groups of these plants had SA applied to them throughout the drought cycle to test the effect of SA on drought resistance. This study found that the SA application helped slow the process of senescence, a common symptom of drought.

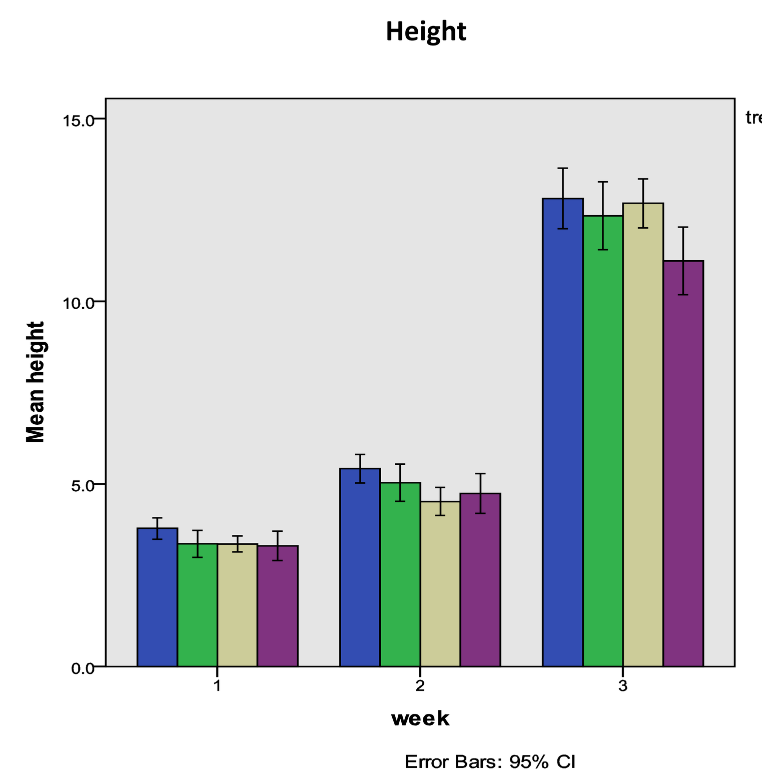
Another similar experiment conducted by Peng-Fei Wen et. al. This experiment focused on the effect of SA application and climate stress. The results of this experiment also point to SA being at least partially responsible for regulation of water and resisting stress. This experiment accredited this to an increase of PAL accumulation and protein formation that allowed the plants to resist the stress more efficiently than the plants that were not given SA.

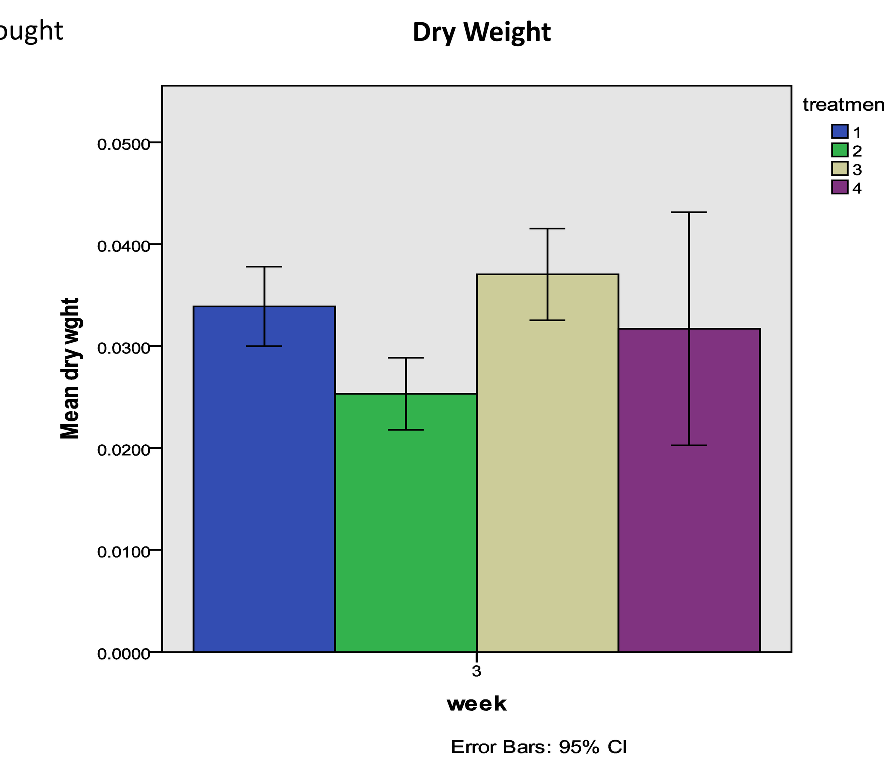
After reviewing these studies, the introduction of SA to different species of plants experiencing different abiotic stresses seems to cause higher levels of resistance to that stress and a more resilient population. The main action of SA seems to be the slowing of the degradation process on a cellular level. After this research we hypothesize that if *B. rapa* is subjected to drought and some plants are given SA topically, that the plants given SA will have a higher resistance to the drought and their growth will resemble the growth of the control rather the drought plants.

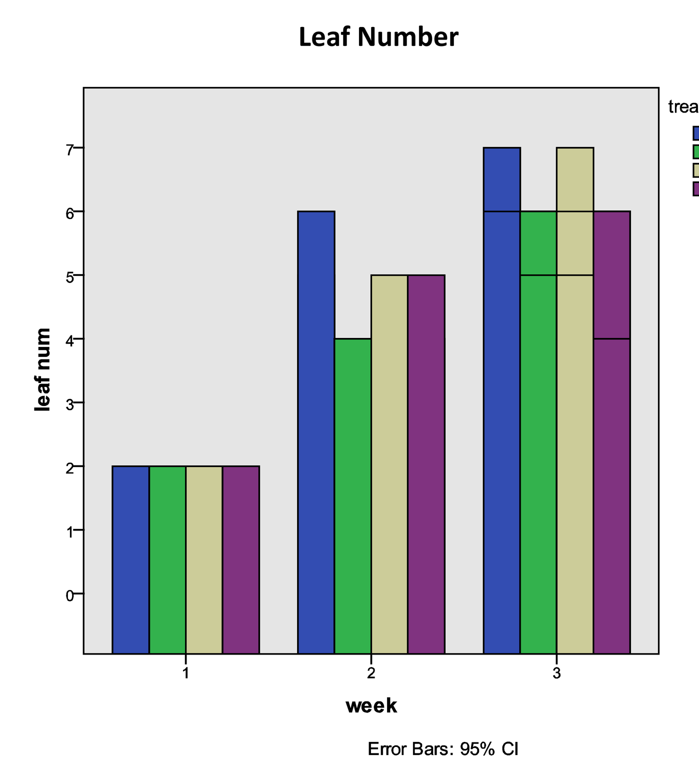
Materials: (about 200) *Brassa rapa* seeds, (about 200) Pots, Ruler, Scale, (4) Trays, Fertilizer pellets , Potting soil, .03 molar salicylic acid, (1) Spray bottle, Grow lamps
First, *Brassa rapa* seeds were planted in the potting soil in small pots. One seed was planted in each individual pot. Each pot was then watered and left to germinate under grow lamps (1 week).
Methods: After the one week time period, the plants that had germinated were initially measured for height and leaf number. Then, 2 pellets of fertilizer were placed in each pot. Then the treatments were applied. One tray was labeled as a "Control". Plants in this tray will receive regular quantities of water (to saturation) and no SA. Another tray was labeled as "Drought". Plants in this tray will receive a lower quantity of water throughout the testing process and no SA. Another tray was labeled "SA". Plants in this tray will receive regular quantities of water (until saturation) and will have .03 molar SA applied weekly with the spray bottle. The final try is labeled "SA + Drought". Plants in this try will receive a lower quantity of water throughout the testing process and .03 molar SA applied topically with the spray bottle weekly. The trays were then put back under the grow lights.
This treatment process was continued over the span of 3 weeks. In between the weekly treatments, the trays that were marked to have normal water quantities were watered until saturation every day, while the trays marked to have the drought stress were not watered until the weekly treatment day.
Measurements were taken weekly on the treatment day. These were as follows. For week 2 measurements were taken of plant height, leaf number, and bud number. For week 3 measurements were taken of plant height, leaf number, bud number, and number of plants that had reached sexual maturity (flowering). The plants were then cut at the base and dried for a week. After the week drying period, the dry weight of each plant was measured using a scale.

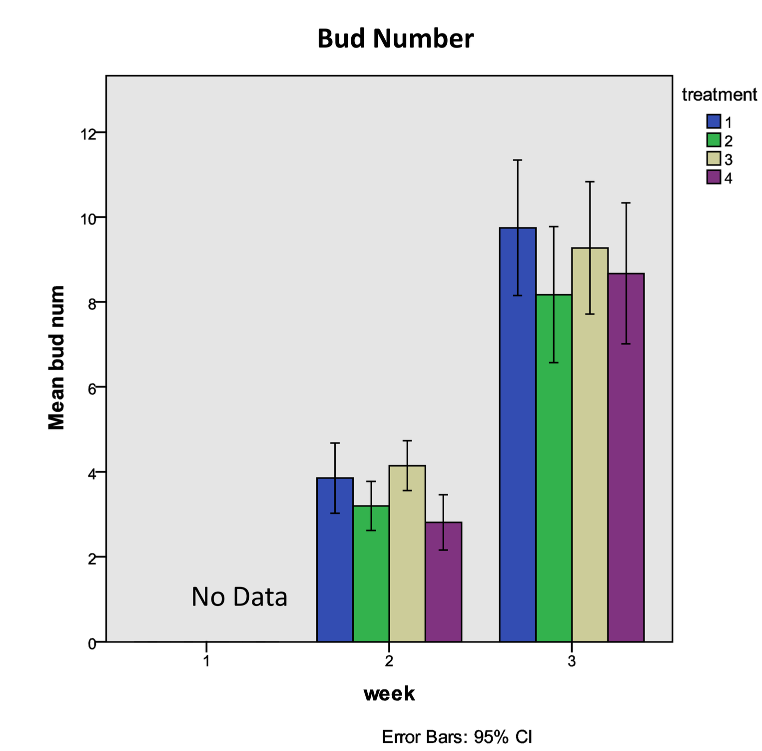
Data Representation

Treatment Key
1: Control
2: Drought
3: Salicylic Acid
4: Salicylic Acid + Drought





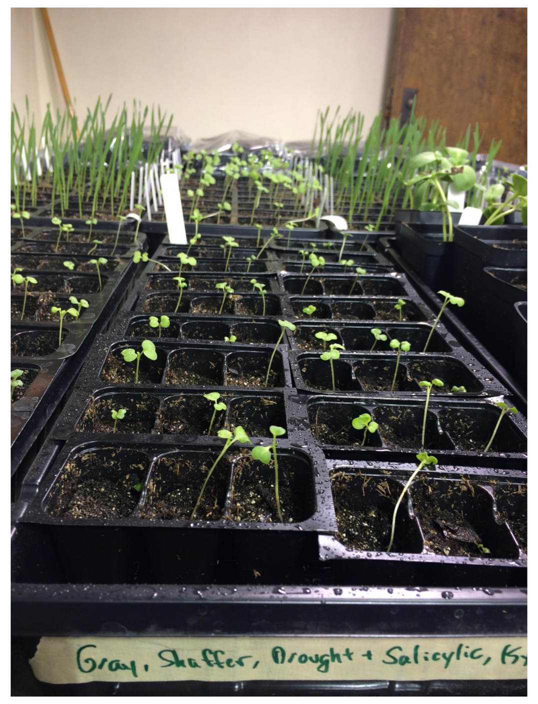




P Values

Treatment/Interaction	Height Week 1	Height Week 2	Height Week 3	# Leaves Week 1	# Leaves Week 2	# Leaves Week 3	# Buds Week 2	# Buds Week 3	# Flowering Plants Week 3	Dry Weight
Salicylic Acid	0.08354	0.00686	0.1083	0.1554	0.1763	0.05726	0.8925	0.9548	0.4421	0.1019
Drought	0.1247	0.6968	0.01274	0.2147	0.002306	0.002691	0.003563	0.1771	0.00009197	0.01653
Interaction	0.2485	0.1844	0.1859	0.2018	0.9313	0.09127	0.3149	0.5428	0.02644	0.5785

Images



Results

The results of this experiment were not what was anticipated. Throughout the course of the experiment, there were visible and quantifiable differences between the trays that were being subjected to drought and that were not, but not much of a difference caused by the application of SA. The data gathered from the experiment shows that SA had little to no effect on most of the traits measured. There was evidence of statistical significance in the difference between the trays with drought and the trays without. Therefore the stress was successfully created. The SA did not seem to allow the plants subjected to the drought resist the stress more efficiently than the plants that were just subjected to drought. There was only one data set involving SA that had a P-value of less than .05; this was the height of the plants at Week 2. But, the height was not affected at Week 3. These p-values indicated that we are not able to reject the null hypothesis for the majority of the experiment, meaning that the original hypothesis was incorrect.

Discussion/Conclusion

The results of the experiment contradict the majority of the research that has already been conducted. In most studies, SA has been shown to increase a plants ability to resist stress. There is more than likely a source of error in the experimental design of the current study. It is possible that using *Brassica rapa* was a mistake due to its extremely short growth period. It is possible that the SA would have had an effect on a plant that does not grow as rapidly; meaning the results couldn't be seen in such a short time period. In a similar experiment to this one, Yeqinn Ying et. al. used an experimental time of 40 days from the first treatment compared to the 21 days in this study. This could be one of the reasons that they were able to get positive results out of this experiment.

Another source of error in the experimental design could have been the application of the drought stress. *Brassica rapa* is recommended to be watered from the bottom up through openings in the bottom of the pot. The watering technique used in this experiment could have been doing more harm than good. It was noted that the plants would fall over or droop after a watering because of how small and delicate they are. This could account for some of the error in the data. Another issue with the drought-inducing system is the fact that the area in which they were grown was flooded with water due to inadequate draining. It was difficult to get the drought plants' soil to be dry. This is probably because there was standing water in the tables they were sitting on causing some water to be wicked up through the soil even when they were supposed to be in drought. Obviously, another cause of error in this experiment could have been human error either with the measuring or the drought application.

Another possible reason for this outcome could be the genetically modified nature of *Brassica rapa*. Rajendra Bari states in an article published in *Plant Molecular Biology* that SA interacts with specific ET signaling pathways in a normal plant. This has to do with repressing certain genes involved in responses to pathogens or stress. Since *B. rapa* is genetically modified to gain fast growth rates, this pathway may have been accidently altered in a way that made SA less effective at resisting stress.

Another possible reason for this outcome could be the concentration of the SA used. For this experiment, .03 molar SA solution was used. In a similar experiment conducted by S. Erdal et. al. used a .05 molar solution, and applied the solution more frequently. This could have contributed to the negative results found in this study. If not enough of the SA was used, without more in-depth analysis of the plants no significant difference would be found.

In conclusion, this experiment did not find any statistical significance in the role of SA in resisting stress in *Brassica rapa*. That is not to say that there is not effect of SA on plant growth or defense, it was just not able to be shown in this specific experiment.

Literature Cited

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