Growth Responses in Cabbage (*Brassica oleracea var. capitata*) under Restricted Water and Light Conditions

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Introduction

Climatic changes, like increasing global temperatures and disruptions in rainfall patterns, are affecting crop yields by impacting plants' growth, development, and nutrient values. Among the affected crops is *Brassica oleracea var. capitata* or cabbage. A vegetable suited for cool seasons, cabbage needs consistent moisture, light, and temperature for harvesting. When such conditions are disrupted, the biomass and growth can be negatively affected.

Gibberellic acid (GA), a hormone that stimulates cell division and affects the growth of stems and leaves, is used by farmers to significantly regulate crop yields. The aim of this study was to determine the effects of restricted water and light conditions on the growth responses in cabbage plants treated with GA and GA-inhibitor (GAI).

Materials and Methods

Cabbage seeds were germinated in a potting mix, and then transplanted into individual pots. The plants were maintained with adequate irrigation and liquid fertilizer in the greenhouse on campus until treatments began.

The plants were divided into three groups to receive one of the following solutions: 1) gibberellic acid (GA, 25mM); 2) gibberellic acid inhibitor (GAI, 25mM); 3) Control (tap water).

[Fall 2022] To test the effect of restricted water conditions, each treatment group was further divided into two subgroups that received one of two irrigation plans: 1) Well-watered (400 mL/week); 2) Drought (200 mL/week).

[Spring 2023] To test the effect of restricted light conditions, each treatment group was divided again into two subgroups that received one of two lighting plans: 1) Full-light (100% light); 2) Shade (50% light).

Results from Irrigation Trials

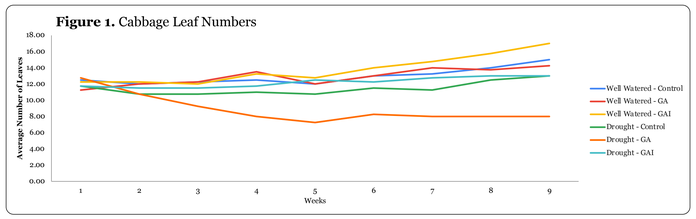


Figure 1: The average number of cabbage leaves attached to the plant during treatment weeks.

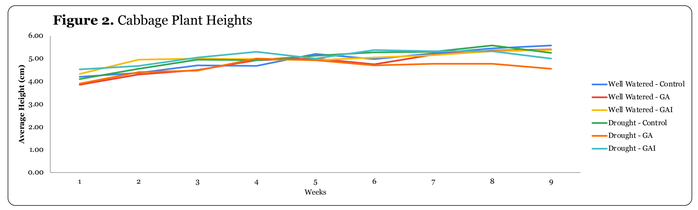


Figure 2: The average height of cabbage plants (stem length) during treatment weeks.

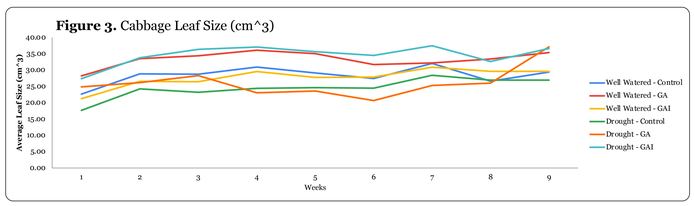
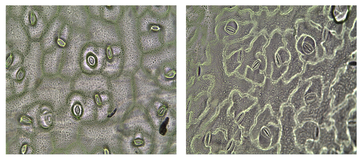
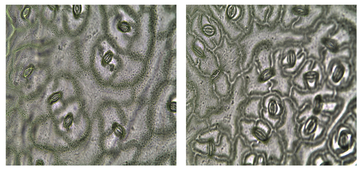


Figure 3: Changes in average cabbage leaf sizes over the treatment weeks.



Well-watered control – top (15 stomata)

Well-watered control – bottom (19 stomata)



Drought control – top (10 stomata)

Drought control – top (17 stomata)

Figure 4: Stomata density and opening of cabbage leaves observed under a compound microscope (400X magnification).

Growth inhibitions were found on cabbage plants under restricted irrigation. GA-treated plants suffered the most, whereas GAI-treated plants performed the best.

Drought stress triggered leaf anatomical changes. Less stomata were made on both top and bottom sides. This discrepancy in stomata numbers between top and bottom sides was more obvious under drought stress, confirming a water conservation strategy of cabbage.

3 weeks			Top (Adaxial Side)			Bottom (Abaxial Side)		
			Total #	Open #	% O/T	Total #	Open #	% O/T
	Drought	Control	15	4	26.7%	23	6	26.1%
		GA	7	2	28.6%	19	6	31.6%
		GAI	5	1	20.0%	8	5	62.5%
	Well watered	Control	7	2	28.6%	13	4	30.8%
		GA	13	4	30.8%	21	6	28.6%
		GAI	9	3	33.3%	14	3	21.4%
6 weeks			Top (Adaxial Side)			Bottom (Abaxial Side)		
			Total #	Open #	% O/T	Total #	Open #	% O/T
	Drought	Control	10	3	30.0%	17	4	23.5%
		GA	15	4	26.7%	18	12	66.7%
		GAI	13	2	15.4%	23	8	34.8%
	Well watered	Control	15	4	26.7%	19	6	31.6%
		GA	9	5	55.6%	14	10	71.4%
		GAI	12	5	41.7%	21	4	19.0%

Table: Stomata density and opening of cabbage leaves after 3 weeks and 6 weeks of plant growth regulator (GA and GAI) treatments.

Results from Light Trials

Light trials are currently taking place in the greenhouse.

Chemical effects have become observable. The Control, GAI-treated, and GA-treated samples (left to right) under 50% light are shown here.

Future Work

Leaf photoreceptors and soluble proteins in the cabbage leaves have been quantified with colorimetric methods in the lab, to reveal the mechanisms underlying the morphological and growth changes.

Data need to be further analyzed.

Acknowledgments

This project was completed under the mentorship of Dr. Yan Xu, Professor of Biology at RCNJ. Thanks also go to the Biology Laboratory Coordinator and Technician for their consistent support.