

The Effect of Human Hormone (Glucagon, Angiotensin2 and Cortisol) on Tomato under of water stress

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ABSTRACT

Charles Darwin was the first to identify plant hormones and published the book *The Power of Movement in Plants*. Later, many scientists continued his work and identified a wide range of plant hormones and their effects on plant growth. Limited food resources are a major concern in the present century. Climate change causes water stress in many plants, and plant hormones, such as abscisic acid (ABA), play a key role. Drawing on experience in the teaching of biology and phytology at the university, the authors extensively studied the effects of human hormones on the lifecycle of plants (the cherry tomato as the first plant). These hormones were used at four concentrations of 0.01, 0.1, 1.0, and 10 mg/l in water. It was found that glucagon at 10 mg/l under water stress increased sucrose content from 0.8 to 1.6 g/100 g. It also significantly enhanced the activity of catalase, polyphenol oxidase, and lipase enzymes. Glucagon shortened the germination period by 2 days relative to the control sample. Angiotensin II at 10 mg/l had a significant effect under water stress on the cherry tomato. Cortisol at 10 mg/l significantly increased the protein content from 0.2 to 1.4 g/100 g under water stress. Moreover, superoxide dismutase, catalase, and ascorbate peroxidase increased, improving the growth index and the seedling length compared to the control sample.

Keywords: Glucagon, Angiotensin II, Cortisol, Superoxide dismutase, Catalase, Ascorbate peroxidase

Introduction

The tomato, scientifically known as *Solanum Lycopersicon*, is native to South and Central America. New tomato varieties have been produced using different methods. Tomato cultivation occupies a total area of nearly three million hectares, accounting for almost one-third of total vegetable production in the world.

Tomatoes are the main source of lycopene antioxidants with multiple health benefits, including reduced cardiovascular disease and cancer risks. They are also a rich source of Vitamin C, potassium, folate, and Vitamin K. The water content of the tomato is nearly 95%, with the remaining 5% consisting of mostly carbohydrates and fibers. A small tomato (100 g) contains 95% water, 0.9 g of proteins, 3.9 of carbs, 2.6 of sugar, 1.2 of fibers, and 0.2 g of fat.

Glucagon is a large polypeptide hormone. It has a molecular weight of 3485, and its chain consists of 29 amino acids. Lipases are enzymes that decompose lipids and fats of animal or human sources into simple forms and facilitate their absorption into

plants. They also hydrolyze triglycerides into fatty acids and contribute to germination. Such fatty acids become simple sugars and provide sufficient nutrients to germinating seeds.

Angiotensin is a protein of type α_2 -globulin consisting of 452 amino acids. It is a precursor for angiotensin II. Angiotensin II has eight amino acids. It has many functions in the human body. Angiotensin II increases the reabsorption of water and sodium in the kidneys. In the case of major bleeding or water and salt losses, angiotensin II increases water and sodium in the body. Therefore, it strongly contributes to the water storage of the body when the body loses a significant amount of water. Angiotensin II is used for vasoconstriction and coagulation. Raising the sodium ion content of the blood is a major function of angiotensin II, enhancing water reabsorption, which is necessary in plants under water stress.

Cortisol is the most important human glucocorticoid secreted by two adrenal glands on top of the kidneys. Corticosteroids pass across the cellular membrane with special complex cytoplasmic receptors into the nucleus. They bind to DNA (chromatin) and

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stimulate mRNA transcription and specific enzymes for the production of different proteins.

Research on the effects of human progesterone on plants has shown that the progesterone concentration is different in only different plant species but also different vegetative and reproductive organs Gupta and Bhattacharya (1981) showed that progesterone at a concentration of 1.4 $\mu\text{M}/\text{l}$ contributed to shoot growth and inhibited root growth [1].

Dumlupinar and Erdal (2011) showed that external intake of progesterone sex hormone significantly enhanced plant growth. Remarkable increases in protein and dissolved sugar concentrations were also reported [2]. Progesterone also led to a substantial rise in the activity of antioxidant enzymes. Erdal (2012) demonstrated that progesterone hormone improved the plant weight under salinity stress conditions [3, 4].

Materials and Methods

Tomato seeds were washed with a 10% sodium hypochlorite solution for 3 min. Then, the samples were washed with distilled water three times [5]. They were soaked in 70% ethanol for 30 s and then re-washed with distilled water before being dried with sterilized tissue paper. The seeds were ready to be moved to the transplant trays.

The lab temperature was set to 25°C. The trays included two control trays without human hormones and twelve trays with hormones. These twelve trays were divided into four trays with four concentrations of glucagon, four trays with four concentrations of angiotensin II, and four trays with four concentrations of cortisol.

A researcher-made fertilizer was employed as the base organic fertilizer. It was produced from vegetable and fruit waste using thermophile bacteria at 70°C. 1 kg of the fertilizer was added to 40 kg of a soil suitable for tomato cultivation. Since cortisol is a steroid hormone, it had a different control tray. As it is water-insoluble, it was dissolved in 3 drops of 96% ethanol solution, adding 2 drops of distilled water. Therefore, 3 drops of 96% ethanol and 2 drops of water were added to the control tray containing cortisol so that the ethanol effect could be neglected. Ten seeds were placed 0.50 cm from the soil in each tray.

Control A: The tray without ethanol was irrigated 2 mm/day in the first five weeks and 6 mm/day in the second five weeks

Control B: The tray with ethanol was irrigated 2 mm/day in the first five weeks and 6 mm/day in the second five weeks

Control C: The tray without ethanol was irrigated 1 mm/day in the first five weeks and 3 mm/day in the second five weeks

Control D: The tray with ethanol (cortisol) was irrigated 1 mm/day in the first five weeks and 3 mm/day in the second five weeks

Results and Discussion

A pot with a diameter of 20 cm and a height of approximately 30 cm would be sufficient for cherry tomato seedlings. The pot was

partially filled with soil, and a seedling was placed within the soil. Then, some more soil was placed on the seedling.

Standard irrigation: tomato seedlings require 2 mm of water per day in the first five weeks and 6 mm per day in the second five weeks. Control pots A and B were naturally irrigated, whereas control pots C and D were irrigated with half the standard water quantity. **Table 1** provides the germination, potting, and ripening times of the control pots.

Table 1. Germination, potting, and ripening times

Sample	Germination	Potting	Ripening
A	Day 8	Day 23	Day 83
B	Day 9	Day 24	Day 84
C	Day 12	Day 27	Day 93
D	Day 15	Day 29	Day 96

Pots A and B showed natural growth. A reduction in the irrigation water quantity delayed germination and, therefore, potting and ripening.

Several concentrations of the hormones were added to the trays. Four trays were prepared for glucagon treatment. They were irrigated under water stress; i.e., 1 mm/day in the first five weeks and 3 mm/day in the second five weeks.

G1: Pot treated with 1 mg/l glucagon

G2: Pot treated with 0.1 mg/l glucagon

G3: Pot treated with 0.01 mg/l glucagon

G4: Pot treated with 10 mg/l glucagon

A1: Pot treated with 1 mg/l angiotensin II

A2: Pot treated with 0.1 mg/l angiotensin II

A3: Pot treated with 0.01 mg/l angiotensin II

A4: Pot treated with 10 mg/l angiotensin II

K1: Pot treated with 1 mg/l cortisol

K2: Pot treated with 0.1 mg/l cortisol

K3: Pot treated with 0.01 mg/l cortisol

K4: Pot treated with 10 mg/l cortisol

Table 2 provides the germination, potting, and ripening times of the treated samples.

Table 2. Germination, potting, and ripening of the treated samples

Sample	Germination	Potting	Ripening
G1	Day 11	Day 26	Day 85
G2	Day 12	Day 27	Day 86
G3	Day 14	Day 29	Day 89
G4	Day 10	Day 24	Day 89
A1	Day 11	Day 25	Day 86
A2	Day 12	Day 27	Day 87
A3	Day 15	Day 29	Day 89
A4	Day 9	Day 22	Day 82
K1	Day 16	Day 30	Day 90
K2	Day 17	Day 31	Day 92
K3	Day 17	Day 31	Day 93
K4	Day 11	Day 22	Day 89

Table 3 reports the sucrose, protein, and carbohydrate contents of the control samples.

Table 3. Sucrose, protein, and carb content of the control samples

Sample	Sucrose (g/100g)	Protein (g/100g)	Carb (g/100g)
A	2.6	0.9	3.6
B	2.4	0.4	3.2
C	1.6	0.3	2.9
D	1.4	0.2	2.5

Table 4 provides the sucrose, protein, and carbohydrate contents of the hormone-treated samples under water stress.

Table 4. Sucrose, protein, and carbohydrate contents of the treated samples under water stress

Sample	Sucrose (g/100g)	Protein (g/100g)	Carb (g/100g)
G4	3.4	1.5	2.4
A4	2.2	1.2	3.6
K4	2.3	1.4	3.7

Then, the effects of glucagon, angiotensin II, and cortisol hormones on the sucrose, protein, and carbohydrate contents of the cherry tomato were evaluated.

Figure 1 plots the effects of glucagon on the sucrose, protein, and carbohydrate contents under water stress.

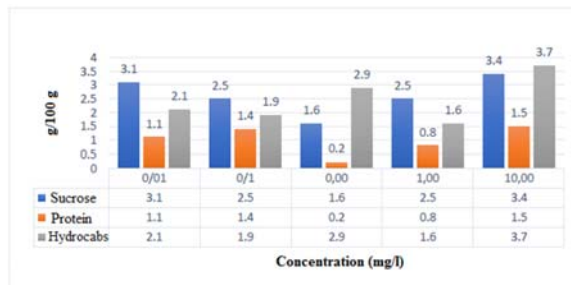


Figure 1. Effects of glucagon at different concentrations on sucrose, protein, and carbohydrate content under water tension

As shown in Figure 1, the optimal glucagon concentration was found to be 10 mg/l, at which the sucrose, protein, and carbohydrate contents significantly rose. Glucagon stimulates the production of lipase, and lipase accelerates germination. This concentration of glucagon improved the germination time by two days under water stress. Moreover, the peroxidase and polyphenol oxidase contents increased.

Figure 2 depicts the effects of angiotensin II on the sucrose, protein, and carbohydrate contents.

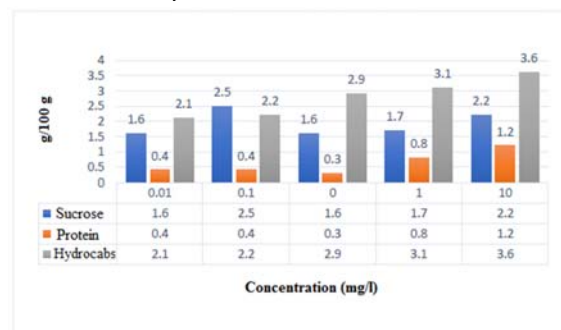


Figure 2. Effects of angiotensin II at different concentrations on sucrose, protein, and carbohydrate content under water tension

According to Figure 2, angiotensin II at a concentration of 1 mg/l significantly enhanced the carbohydrate content of the cherry tomato under water tension. It strongly contributed to the passing of minerals into the xylems and, therefore, water would not be discharged due to osmosis. As a result, angiotensin II played a key role in coping with water tension. It also maximized the protein and sucrose contents of the tomato at a concentration of 10 mg/l.

Figure 3 plots the effects of cortisol on the sucrose, protein, and carbohydrate contents of the tomato. At a concentration of 10 mg/l, cortisol increased transcription in plant cells and remarkably enhanced the protein content. The increased transcription increased enzymes (which are proteins).

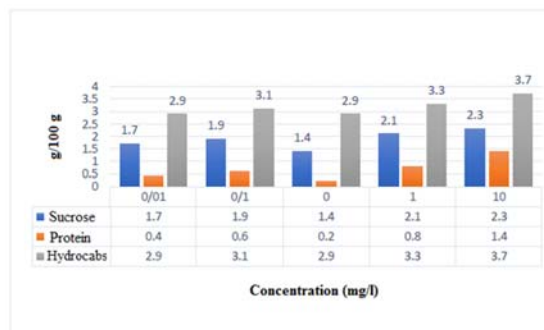


Figure 3. Effects of cortisol at different concentrations on sucrose, protein, and carbohydrate content under water tension

Conclusion

Glucagon at 10 mg/l increased the sucrose content of the cherry tomato from 2.7 to 3.9 g/100 g. It also significantly increased the activity of the catalase, polyphenol oxidase, and lipase enzymes. The glucagon-treated tomato showed a two-day shorter germination time.

Angiotensin II at 10 mg/l had a significant effect on the tomato compared to the control sample under water tension. It accelerated germination by two days and ripening by nine days. Cortisol at 10 mg/l accelerated germination by four days compared to the control sample. It also reduced the ripening time of the tomato under water tension. The protein content of the tomato significantly increased from 0.8 to 1.4 g/100 g. Superoxide dismutase, catalase, and ascorbate peroxidase also increased, and the growth index and seedling length of the cortisol-treated sample where found to be greater than those of the control sample.

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Conflict of interest: Since this project uses human hormones, it does not pose any threat to human health.

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