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Article

The Effect of Heat and Drought on The Growth Response of The Callistemon Viminalis Plant

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Abstract: The results from the study indicate clear negative effects of both heat and drought on the growth and response of the Callistemon Viminalis plant. The rate of transpiration and relative water content decreased significantly under the influence of heat, indicating water stress. The rate of photosynthesis has also declined, which negatively affects the plant's ability to produce energy. In contrast, levels of proline content and antioxidant activity increased, indicating a plant's response to heat stress. However, the chlorophyll content decreased, reflecting the deterioration of plant health. A decline in growth and an increase in yellowing of leaves were also observed, reflecting the harmful effect of heat. Under the influence of drought, the rate of transpiration and relative water content also experienced a significant decrease, demonstrating the plant's adaptation to extreme conditions by closing the stomata. The rate of photosynthesis has also decreased significantly, which negatively affects energy production. Proline content and antioxidant activity increased, demonstrating a positive response to water stress. However, the deterioration of chlorophyll content affects plant health, as growth decreases and leaves yellowing increases, reflecting the detrimental effect of drought.

Keywords: Calistemon Viminalis, Heat, Drought, Transpiration Rate, Photosynthetic Rate

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1. Introduction

Plants are a key pillar in the ecosystem, playing a pivotal role in providing oxygen and nutrition, and controlling the climate. Among these plants, the Callistemon Viminalis plant stands out as an important species, especially in dry and hot regions characterized by noticeable climatic changes. This plant is adaptable to extreme conditions, making it ideal for cultivation in environments with water shortages and high temperatures[1-3].

This tree or shrub is called the red bottle brush because of its flowers that resemble the shape of the brush with which we clean the bottle (glass bottle)[4,5]. A small tree with a strong trunk standing hard brown color bears a range of salinity but is not preferred and be planted near the shore. The height of the tree is 2 to 4 meters and prefers direct lighting and prefers regular and moderate irrigation and its leaves are narrow, lenticular leathery with an aromatic smell similar to the smell of citrus. And its flowers grow in cylindrical spikes with a crimson color The petals take the form of a brush[5-8],

With ongoing climate changes, challenges such as drought and rising temperatures are becoming more common, directly affecting plant growth and productivity. High heat and dehydration lead to a range of physiological effects, including reduced transpiration, reduced photosynthesis, and increased proline content, which is a sign of water stress. These changes may lead to a deterioration in plant health, specifically in its ability to grow and produce[8-10].

This study is based on an analysis of the effects of heat and drought on the Callistemon Viminalis plant, where changes in growth rates, relative water content, and stress indicators, such as proline content and antioxidant activity, will be monitored. This study seeks to provide valuable insights into how this plant adapts to extreme environmental conditions, which can contribute to the development of effective agricultural strategies to ensure the sustainability of the productivity of the Callistemon Viminalis plant in the future[11,12].

2. Materials and Methods

a. Callistemon Viminalis Homogeneous plants were selected in age and size.
b. Thermometers: A digital thermometer to measure air and soil temperature.
c. Soil moisture measuring devices: to determine the level of moisture in the soil.
d. Measures of height: to measure plant growth.
e. Laboratory instruments: such as test tubes, balances, and concentration measuring devices.
f. Chemical solutions: to analyze the content of proline and the activity of antioxidants.

Experiment steps

a. Planting an equal number of champion mattress plants in homogeneous planting pots as in Figure 1.



Figure 1. A group of Callistemon Viminalis.

b. Dividing plants into two groups: one that is exposed to heat and drought, and another that is controlled in moderate conditions.
c. Adjust temperatures in the heat-exposed group (40 ° C) using suitable heat sources.
d. Gradually reduce the level of soil moisture in the drought group, while recording moisture levels as in Figure 2.



Figure 2. Humidity meter.

e. Measuring some characteristics such as the rate of transpiration, the rate of photosynthesis and monitoring the growth of leaves as in Figure 3 .



Figure 3. Transpiration rate measuring device.

3. Results and Discussion

The effect of heat on the Callistemon viminalis plant

a. Transpiration Rate

95% to 81%: A clear drop indicates water stress caused by heat. A low rate of transpiration means that the plant is trying to reduce water loss[13].

b. Relative Water Content - RWC

95% to 76%: indicates significant loss of water, which affects plant health and ability to grow.

c. Photosynthetic Rate

From 92% to 78%: decrease in photosynthesis rate due to heat stress, which negatively affects the energy production of the plant.

d. Proline Content

From 4.92 μmol/g to 14.63 μmol/g: a significant increase indicating a plant's response to heat stress, with proline acting as cell protection[14].

e. Antioxidant Activities

From 1.3 U/g to 2.47 U/g: An increase in antioxidant activity reflects the plant's response to protect itself from damage caused by free radicals[15].

f. Chlorophyll content

From 38 μg/ml to 30 μg/ml: a decrease in chlorophyll content indicates a deterioration in plant health.

g. Growth Monitoring

10.33 cm to 7.89 cm: Decline in growth, reflecting the harmful effect of heat.

h. Monitor the Status of Leaves

4% to 18% Yellowing: An increase in yellowing of leaves indicates a deterioration in plant health.

Table 1 and Figure 4 and 5 show the results of the effect of heat on the growth of the response of the Callistemon Viminalis plant .

Table 1. The results of the heat effect.

TEST	From 1 to 5 days	From 5 to 10 days	From 10 to 15 days
Transpiration Rate	95%	89%	81%
Relative water content (RWC)	95%	88%	76%
Photosynthetic Rate	92%	87%	78%
Proline Content	4.92 µmol/g	9.78 µmol/g	14.63 µmol/g
Antioxidant activities	1.3U/g	1.81 U/g	2.47 U/g
chlorophyll content	38µg/ml	33 µg/ml	30 µg/ml
growth monitoring	10.33cm	9. 72cm	7. 89cm
Monitor the status of papers	4 % Yellowing	13 % Yellowing	18 % Yellowing

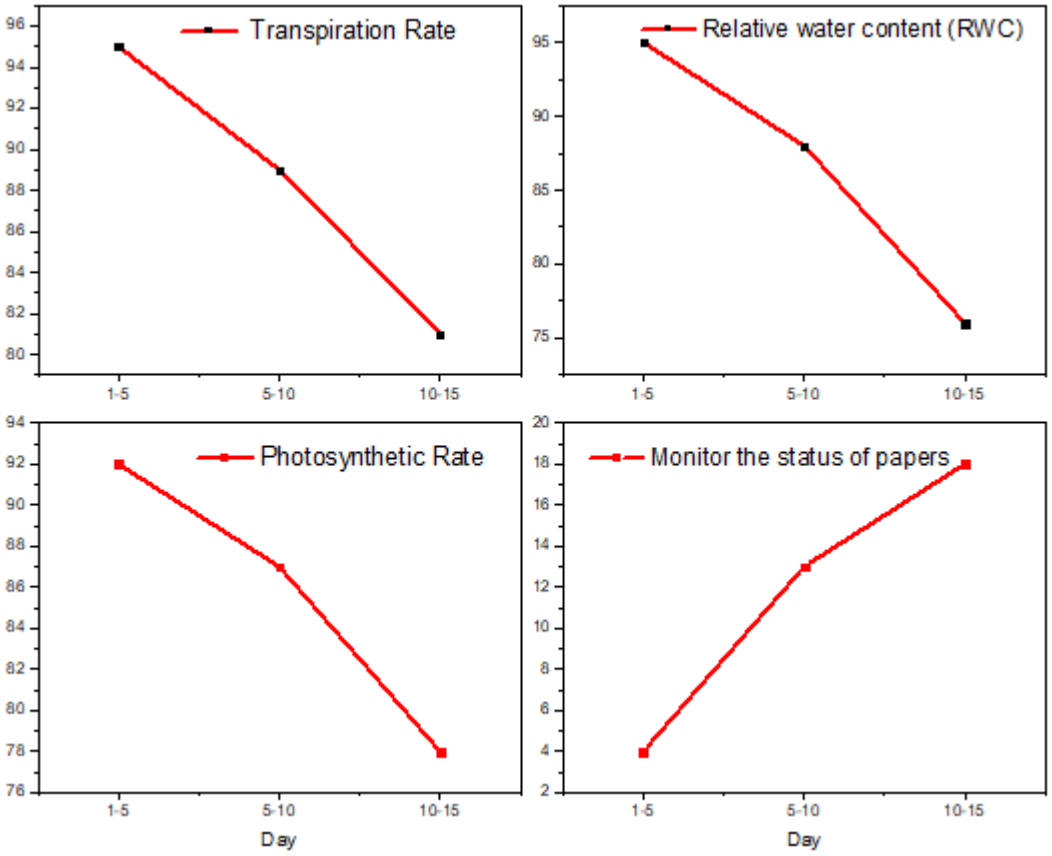


Figure 4. Shows the rates of transpiration, photosynthesis, and leaf growth rate under the influence of heat.

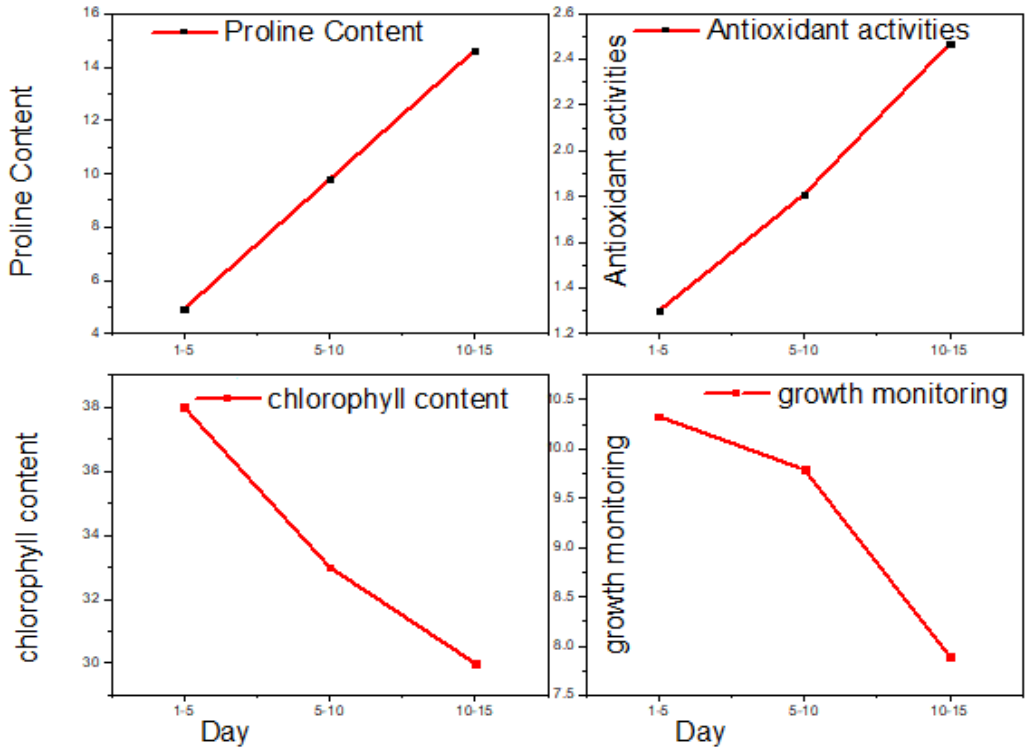


Figure 5. Shows the proportions of chlorophyll and proline and oxidative activity under the influence of heat.

Effect of drought on the growth of the Callistemon viminalis plant response

a. Transpiration rate

88% to 74%: also indicates a significant decrease, indicating that the plant closes the stomata to reduce water loss under drought conditions[16].

b. Relative Water Content (RWC)

93% to 71%: A significant decrease indicates significant water loss as a result of dehydration[17].

c. Photosynthetic rate

90% to 75%: decrease The effect of drought on the plant's ability to carry out photosynthesis.

d. Proline Content

From 4.73 µmol/g to 16.54 µmol/g: a marked increase reflecting the plant's response to water stress, indicating its adaptation to extreme conditions[18].

e. Antioxidant Activities

1.57 U/g to 2.32 U/g: An increase in activity indicates the plant's response to protect itself from drought damage[19].

f. Chlorophyll content

From 40 µg/ml to 32 µg/ml: a marked decrease, indicating the effect of drought on plant health.

g. Growth Monitoring

10.18 cm to 6.64 cm: Decline in growth, reflecting the adverse effect of drought.

h. Monitor the Status of Leaves

5% to 19% Yellowing: An increase in yellowing of leaves indicates negative effects on plant health due to drought[20].

Table 2 and Figure 6 and 7 show the results of the drought effect on the champion mattress plant.

Table 2. Results of the drought effect.

TEST	From 1 to 5 days	From 5 to 10 days	From 10 to 15 days
Transpiration Rate	88%	83%	74%
Relative water content (RWC)	93%	84%	71%
Photosynthetic Rate	90%	82%	75%
Proline Content	4.73 µmol/g	10.43 µmol/g	16.54 µmol/g
Antioxidant activities	1.57 U/g	2.04 U/g	2.32 U/g
chlorophyll content	40 µg/ml	37 µg/ml	32 µg/ml
growth monitoring	10.18 cm	8.97 cm	6.64 cm
Monitor the status of papers	5 % Yellowing	15 % Yellowing	19 % Yellowing

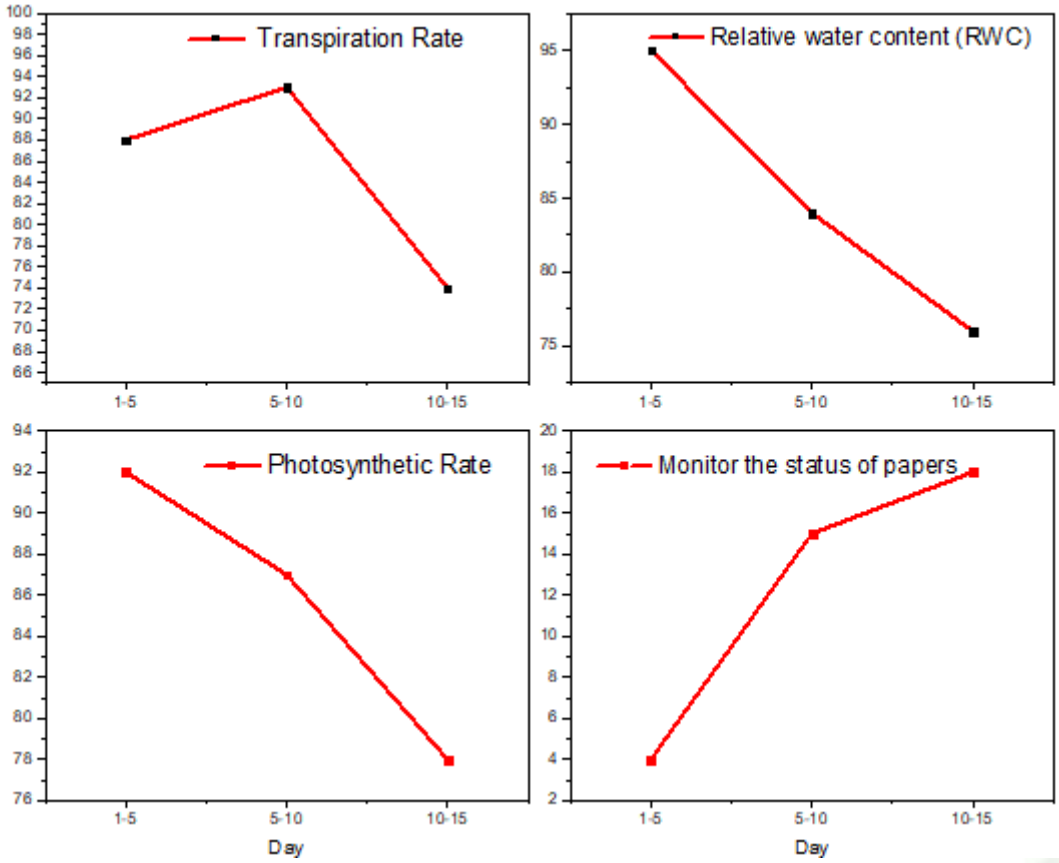


Figure 6. Shows the rates of transpiration, photosynthesis, and leaf growth rate under the influence of drought.

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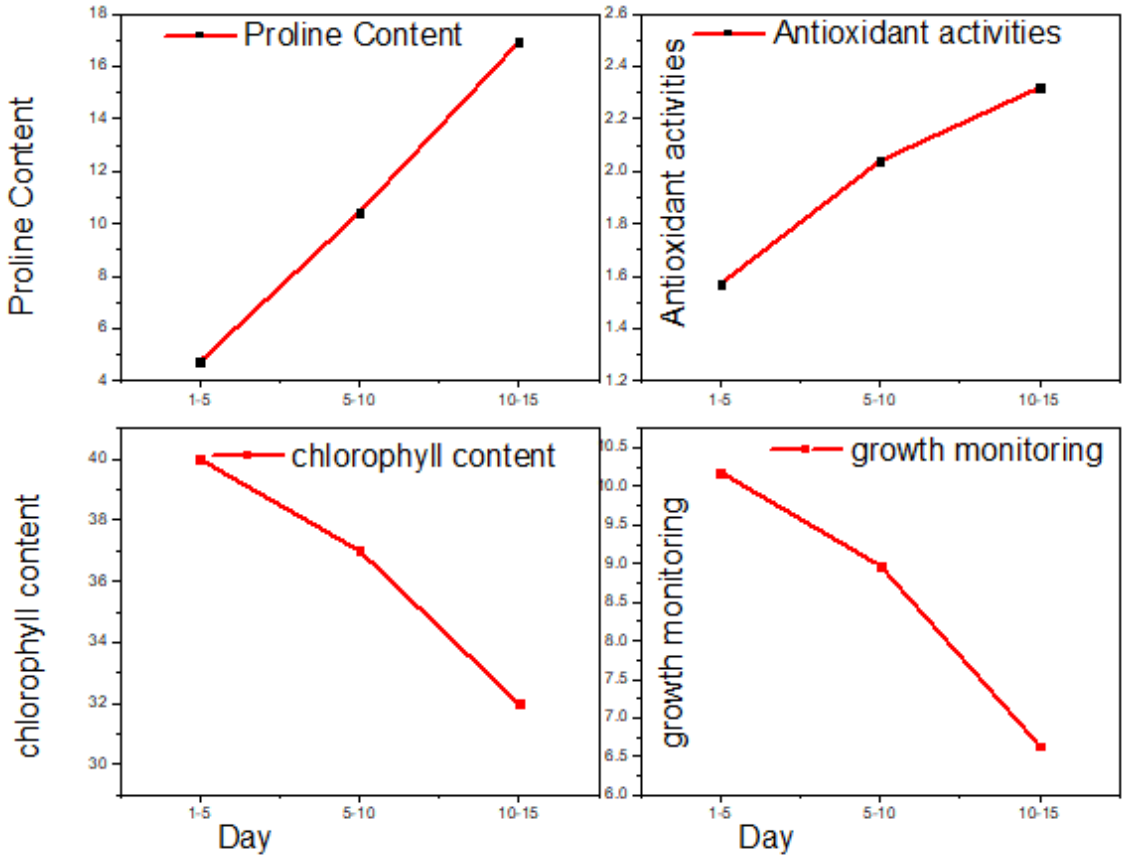


Figure 7. Shows the proportions of chlorophyll and proline and oxidative activity under the influence of drought.

4. Conclusion

The results suggest that both heat and drought have significant negative effects on the growth and response of the Callistemon Viminalis plant. Low rate of transpiration, water content, and rate of photosynthesis, in addition to degradation of chlorophyll content, plant stress reflects. Therefore, understanding how environmental factors such as heat and drought affect the growth and response of the Battrush plant is critical, not only to preserve this plant species, but also to enhance food security in areas affected by climate change.

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