Florea: Jurnal Biologi dan Pembelajarannya
Vol. 11, No. 1, May 2024, pp. 41~45
ISSN 2355-6102; e-ISSN 2502-0404 DOI: 10.25273/florea.v11i1.21188

The Impact of Drought Stress on The Growth of Water Spinach (*Ipomea Reptans* Poir)

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Article Info

Article history:
Received February 10, 2024
Revised March 15, 2024
Accepted May 31,2024

Keywords:

Water spinach,
Drought stress,
Stomata,
Morphology

ABSTRACT

Water spinach (Ipomoea reptans Poir) is a commonly cultivated vegetable in tropical regions like Indonesia. Water spinach faces challenges related to water availability, which can impact various cellular, biochemical, and physiological aspects. Drought can lead to reduced vegetative growth, and a lack of water can inhibit overall plant growth. Therefore, understanding the growth response of water spinach to water stress is crucial for achieving optimal results. This study used a Completely Randomized Design (CRD) with water concentration as the treatment. Water spinach seeds were selected before being sown and transferred to polybags. Irrigation was conducted with five levels of concentration: 100% (300 ml of water), 75% (225 ml of water), 50% (150 ml of water), 25% (75 ml of water), and 0% (0 ml of water). Observations were made at 14 days old with agronomic and anatomical parameters, and the data were analyzed using MANOVA followed by a Tukey post-hoc test at a 5% significance level with SPSS. The results showed that irrigation with 300 ml and 225 ml of water produced the highest number of stomata and the longest stomata size. For stomatal width, treatments of 300 ml, 225 ml, and 75 ml resulted in wider stomata. Meanwhile, for stomatal area, the 225 ml treatment showed the largest stomatal size. However, no significant differences were observed in plant height and leaf number among the treatments. Drought stress affects photosynthesis and plant growth, with increasingly severe impacts as drought intensity rises. Drought results in reduced stomatal number, smaller stomatal size, and inhibited plant growth

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1. INTRODUCTION

Water spinach (Ipomoea reptans Poir) is a vegetable commonly cultivated in tropical regions such as Indonesia and is known to have high content of vitamin A, vitamin C, as well as minerals, including iron (Idris, 2020; Wibowo and Sitawati, 2017). Terrestrial plants like water spinach face challenges related to water availability, which can affect various cellular, biochemical, and physiological aspects of the plant (Syiam et al., 2021). Stress, both biotic and abiotic, can reduce plant physiological processes. Drought stress occurs when soil moisture is insufficient for plant growth and production, which can hinder growth, yield, and even lead to plant death. (Latifa and Rachmawati, 2020). Drought can lead to a decrease in vegetative growth, such as plant height, stem diameter, number of leaves, and leaf area (Wibowo and Sitawati, 2017). Leaves, as the main organs for photosynthesis, have a thin, flat shape and a large surface area to capture light (Syiam et al., 2021).

Water is an essential component required for biochemical processes and plant development (Gaso et al., 2022). Water serves as a major part of the cell protoplasm, a solvent, and a transportation medium (Wibowo and Sitawati, 2017). Additionally, water aids in the formation of new compounds, maintenance of turgor pressure, and plant temperature regulation (Idris, 2020). Water deficiency can hinder vegetative growth as it is not only crucial for photosynthesis but also as a key component of protoplasm (Wibowo and Sitawati, 2017).

Water loss in plant tissues leads to a decrease in turgor pressure, which can stop cell growth and hinder overall plant growth. Reduced turgor also disrupts the biosynthesis of essential components such as cell walls, chlorophyll, enzymes, and proteins (Latifa and Rachmawati, 2020). The growing medium and watering methods significantly influence the growth and development of water spinach, with both water deficiency and excess potentially causing growth disturbances. Water scarcity can lead to plant death, while water excess can damage the roots due to the lack of air in waterlogged soil (Idris, 2020). Therefore, understanding the growth response of water spinach to water stress is essential for achieving optimal yields.

2. METHOD

This research design is structured using a basic pattern of a Completely Randomized Design (CRD) with a single factor of water concentration, consisting of 5 levels, namely:: 100% (300 ml water), 75% (225 ml water), 50% (150 ml water), 25% (75 ml water) 0% (0 ml water)

1. Planting seeds.

Before sowing, the seeds must first be selected. The selection process involves placing the seeds in a container filled with water. Seeds that float are considered of lower quality for planting, while seeds that sink are considered good for planting. After selecting the water spinach seeds, the seedlings are then transferred into polybags, with 5 plants per polybag forming one cluster. Watering is then done adequately to ensure the soil in the polybags remains moist..

2. Maintenance and Watering

Maintenance is carried out by watering the water spinach plants twice a day, in the morning and evening, with the following treatments: P1 (300 ml of water), P2 (225 ml of water), P3 (150 ml of water), P4 (75 ml of water), and P5 (0 ml of water).

3. Observation and Measurement.

Observations are made after the plants reach 14 days of age. The parameters examined include agronomic aspects, such as plant height and number of leaves, as well as anatomical aspects, which include the length, width, number, and area of the stomata.

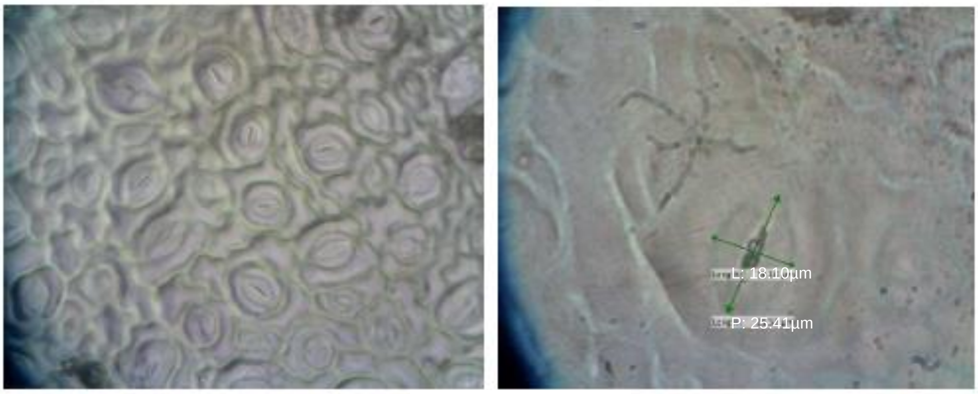
4. Data Analysis

The data from the observations on various parameters are analyzed using MANOVA with SPSS..

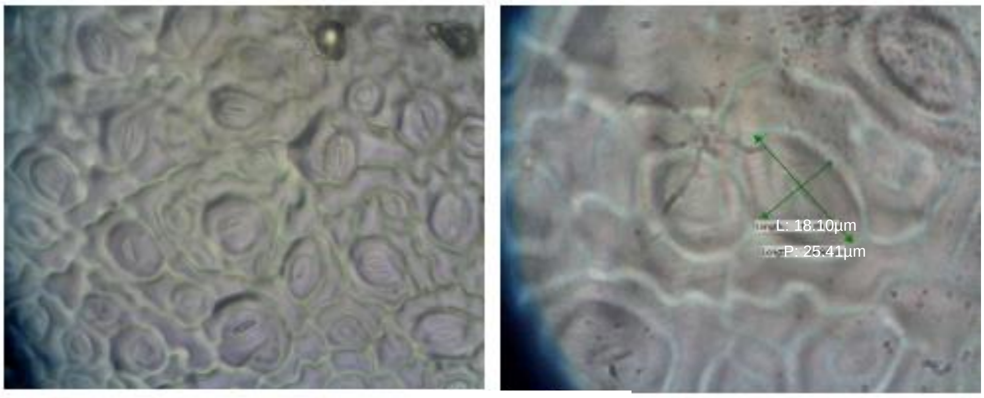
3. RESULTS AND DISCUSSION

The treatments used in this study with 5 levels resulted in varying data. The treatments were based on the water requirements of vegetable plants, ranging from 200 to 600 ml per day. According to Dewi et al. (2017), vegetable plants require about 0.275 liters per day. The analysis results using Tukey's test at a 5% significance level for parameters such as stomatal count, stomatal length, stomatal width, stomatal area, and plant height showed significant effects from the treatments, as presented in Table 1. The comparison of images for each treatment is shown in Figure 1.

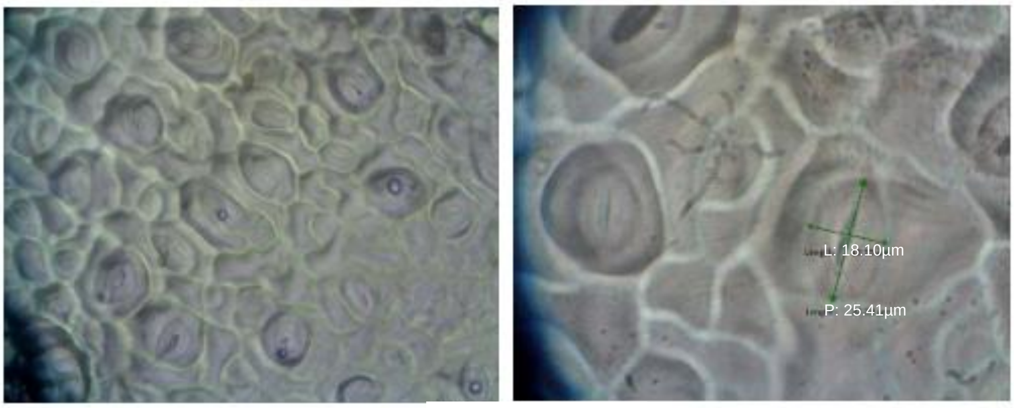
Figure 1. Comparison of Stomata for Each Treatment.



Treatment 1



Treatment 2



Treatment 3

Table 1. Manova Analysis Results

Treatment	Number of somata	Stomata length	Stomata Width	Stomata Area	Plant Height	Number of Leaves
300 ml water	36.00a	25.41b	18.10a	459.92b	17.73a	3.00a
225 ml water	35.00a	28.52a	17.48ab	498.60a	14.93a	2.66a
50 ml water	26.00b	24.14c	16.25c	392.49c	14.66a	3.00a
75 ml water	23.00c	24.38c	18.67a	455.48b	13.50a	2.66a
0 ml water	13.33d	15.25d	10.32d	157.52d	8.50b	3.00a

The analysis results using Tukey's test show that the treatments with 300 ml and 225 ml of water resulted in the highest stomatal count and the longest stomatal length. For the stomatal width parameter, treatments with 300 ml, 225 ml, and 75 ml of water resulted in wider stomata. For the stomatal area parameter, the treatment with 225 ml of water showed the largest stomatal area. Additionally, for the plant height and number of leaves parameters, no significant differences were observed across all treatments.

Drought stress is a condition where the soil moisture content reaches the lowest level necessary for plant growth and production (Sujinah and Ali, 2016). Drought stress can cause various negative impacts on plants, affecting their morphological, biochemical, and physiological aspects (Bangar et al., 2019). Based on observations, drought stress can reduce the number and size of stomata in plants. Munir et al. (2022) stated that plants experiencing drought stress will show a reduction in leaf length, aimed at limiting leaf expansion and reducing the number of stomata to prevent excessive transpiration.

Furthermore, stomatal parameters show a decrease due to drought stress. Mastur (2016) stated that the plant's initial response to drought is to close the stomata. Over the long term, the plant will experience changes in growth, particularly with an increase in root growth. Plants adapt to drought by extending their roots to search for water sources when drought stress occurs. Plants facing drought stress tend to be smaller in size compared to those grown under normal conditions. Additionally, drought stress affects various aspects of plant growth and metabolism, including membrane integrity, pigment content, osmotic balance, photosynthetic activity, a decrease in protoplasmic water potential, reduced growth, and reduced stem diameter (Sinay, 2015).

The length of stomata on plant leaves is influenced by internal factors, namely the mechanism of stomatal opening and closing, which is regulated by the turgor pressure of the guard cells. Both ends of the guard cells are in contact, so when turgor pressure increases, the guard cells curve, forming a long slit. According to Rohman and Hamida (2017), the formation of the stomatal slit is caused by two structural factors of the guard cells: first, the ends of the guard cells are in contact, causing the guard cells to curve when turgor pressure increases and forming a slit bounded by the cell wall; second, radial microfibrillation, which affects the length and width of the stomata, and when turgor pressure increases, it causes the guard cells to curve, thereby opening the stomata.

Furthermore, regarding plant height, drought stress treatments affect the reduction in plant height. Uyun (2010) explains that reduced water availability leads to a decrease in water supply to the root zone, which results in the inhibition of water absorption by the roots. This creates problems during the plant's vegetative growth phase, such as smaller leaf sizes, inhibited growth, decreased plant weight, and reduced stem diameter. Water deficiency can disrupt physiological processes in plants, affecting photosynthesis rates due to protoplasmic dehydration, which in turn reduces photosynthesis and slows down plant growth and development. Therefore, stomata have a significant impact on plant growth because they are the entry points for CO2 used in photosynthesis. In other words, the higher the rate of photosynthesis, the faster the plant growth; conversely, if photosynthesis is low, plant growth will be inhibited. A similar study by Gea (2024) stated that drought stress in green mustard (*Brassica juncea* L) plants resulted in slowed growth.

4. CONCLUSION

Drought stress treatment affects photosynthesis and plant growth, with the impact becoming greater as the intensity of drought stress increases. Drought stress causes a decrease in the number of stomata, reduces stomata size, and inhibits plant growth

REFERENCES

[1] Aulia, S., Ansar., dan Putra, G. M. D. 2019. Pengaruh Intensitas Cahaya Lampu Dan Lama Penyinaran Terhadap Pertumbuhan Tanaman Kangkung *(ipomea reptans poir)* Pada Sistem Hidroponik Indoor. *Jurnal Ilmiah Rekayasa Pertanian dan Biosistem*, 7(1): 43-51.

[2] Bangar, P., Chaudhury, B.A., Tiwari., dan Kumar, S. 2019. Morphological and Biochemical Response of Mungbean (*Vigna radiata* L. Wilczek) Varieties at Different Developmental Stages Under Drought Stress. *Turkish Journal Bio*logy. 43: 58-69.

[3] Dewi, V.A.K., Setiawan, B.I, dan Waspodo, R.S.B. 2017. Analisis Konsumsi Air Sayuran Organik Dalam Rumah Tanaman. *Jurnal Irigasi*. Insitut Pertanian Bogor. 12(1): 37-46.

[4] Gea, R.O.H. 2024. Pengaruh Cekaman Air Dan Pemberian Pupuk Daun Terhadap Pertumbuhan Dan Hasil Tanaman Sawi Hijau (*Brassica Juncea* L) *Jurnal Agrotekda*. Universitas Darma Agung. 8(1): 46-57.

[5] Gaso, T. M., Bare, Y., Bunga, Y. N., dan Jaya, S. H. 2022. Respon Pertumbuhan Tanaman Kangkung Darat *(Ipomea reptans* Poir) setelah Pemberian Arang Sekam Padi. *Jurnal Biologi dan Pendidikan Biologi*. 2(2): 11-19.

[6] Idris, M. 2020. Respon Pertumbuhan Vegetatif Tanaman Kangkung (Ipomoea Reptans Poir) Akibat Perlakuan Media Tanam dan Metode Pemberian Air. *Jurnal Klorofil*, 4(1): 39-47

[7] Latifa, A dan Rachmawati, D. 2020. Pengaruh Osmopriming Benih terhadap Pertumbuhan dan Morfofisiologi. *Jurnal Agron Indonesia,* 48(2):165-172

[8] Mastur, M. 2016. Respon Fisiologis Tanaman Tebu terhadap Kekeringan. *Buletin Tanaman Tembakau, Serat, dan*

Minyak Industri. 8(2): 98-111.

[9] Munir, M.S., Avivi, S., dan Soeparjono, S. 2022. Pengaruh Dosis Pupuk KCl dan Berbagai Level Penyiraman Terhadap Pertumbuhan Bibit Kelapa Sawit (*Elaeis guineensis* Jacq.) di Pre- Nursery. *Agriprima Journal of Applied Agricultural Sciences*. 6(1): 62-72

[10] Rohman, F., dan Hamida, R. 2017. Keragaman Karakter Morfologi, Stomata, dan Klorofil Enam Varietas Tembakau Lokal Tulungagung. *Buletin Tanaman Tembakau, Serat dan Minyak Industri*. 9(1): 15-23.

[11] Sujinah, dan Ali, J. 2016. Mekanisme Respon Tanaman Padi Terhadap Cekaman Kekeringan dan Varietas Toleran. *Jurnal Iptek Tanaman Pangan*. 11(1): 1-8.

[12] Sinay, H. 2015. Pengaruh Perlakuan Cekaman Kekeringan terhadap Pertumbuhan dan Kadungan Prolin pada Fase Vegetatif Beberapa Kultivar Jagung Lokal dari Pulau Kisar Maluku di Rumah Kaca. *Prosiding Seminar Nasional Pendidikan Biologi*. Universitas Pattimura. Ambon.

[13] Syiam, N. R., Amalia. L., dan Putri, D. I. 2021. Analisis Perbedaan Bentuk, Ukuran dan Jumlah Stomata Kangkung Air (Ipomoea aquatica Forsskal) dan Kangkung Darat *(Ipomoea reptans Poir). Jurnal Life Science,* 3(1): 15-24

[14] Uyun. (2010). Optimasi Uji Toleransi Varietas Kedelai (*Glycine max Merril* (L.) pada Cekaman Kekeringan dalam Media In Vitro Cair dengan Polietilena Gilkol (PEG) 6000. *Skripsi*. Malang. Jurusan Biologi Universitas Islam Negeri Maulan Malik Ibrahim.

[15] Wibowo, Y.H., dan Sitawati., 2017. Respon Tanaman Kangkung Darat (*Ipomoea reptans Poir)* dengan Interval Penyiraman Pada Pipa Vertikal. *Journal of Agricultural Science,* 2(2):148-154.