

Morphological Response of Takka Plant (*Tacca leontopetaloides* L.) as Traditional Medicine for Drought Stress

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ABSTRACT

Contains a brief description of research Abstract: Alternative medicine using herbs has been very popular in Indonesia in the last few decades. Takka plants contain secondary metabolite compounds that can be used as medicinal materials, it is necessary to administer drought stress. The purpose of this study is to study the morphological response of the takka plant (*Tacca leontopetaloides* L.) as a traditional medicine against drought stress. This research was carried out in the pilot garden of the Faculty of Agriculture, Khairun University, Ternate. It took place from June to April 2018. It was arranged in a split-plot using RAK with two factors and three replications, namely the first factor, genotype as the main plot, consisting of three populations namely G1: Gorango, G2: Gurua, G3: Beksili. The second factor, media water content as subplots, which consists of four levels, namely K1: MWC 100%, K2: 75%, K3: 50%, K4 25%. Data were analyzed using the formula: $Y_{ijk} = \mu + \rho_k + \alpha_i + \beta_j + (\alpha\beta)_{ij} + Y_{ik} + \epsilon_{ijk}$. The results showed that the treatment of drought stress at 100% and 75% water content had a significant effect on plant height, dry leaf weight, stem diameter, fresh tuber weight, dry tuber weight, tuber diameter. The treatment of drought stress at 25% media moisture content had a significant effect on the number of tubers and the number of shoots (23.6%).

Keywords: takka plant, drought stress, media water content

I. INTRODUCTION

Alternative medicine using herbs has become very popular in Indonesia in the last few decades. Takka plant is one of the plants that can be used as a medicinal ingredient [1, 2], containing secondary metabolites [3,4]. Secondary metabolites produced by plants in a certain amount in a gripping condition [5]. To increase secondary metabolites [6], it is necessary to administer drought stress.

The takka plant is a seasonal plant that is drought resistant. [7] water scarcity is a severe environmental constraint for crop productivity [8]. Plants adapt to drought conditions by various physiological, biochemical, anatomic, and morphological changes, including transitions in gene expression, [9] plants adapt to drought.

Trought is a climate phenomenon that can occur periodically in all climate zones [10], as a limiting factor for the accumulation of compatible osmotic plants [11], as the main limitation on crop yields and productivity throughout world [12], influencing plant growth and development [13].

The takka cultivation has not been done, because many people are not familiar with this plant. This plant grows in coastal areas and is understanding stands. Water availability is very dependent on rainfall intensity because the land in North Maluku is dry land and takka plants are allowed to grow wild without being cultivated. Therefore, research on providing water stress is important to obtain suitable growing environmental conditions.

This study aims to evaluate the morphological response in three takka plants (*Tacca leontopetaloides* L.) as a medicinal plant against drought stress.

II. MATERIALS AND METHODS

A. experimental design

This study was arranged in a split-plot using a randomized block design (RCBD) with two factors, i.e. The first factor, genotype as the main plot, which consists of three seeds, that is : G1: Gorango, G2: Gurua, G3: Beksili.

The second factor, media water content (MWC) as a subplot, which consists of four levels, i.e. K1: 100% water content, K2: 75% water content, K3: 50% water content,

K4: 25% water content. Thus, overall 12 treatment combinations were obtained. Each treatment was repeated three times so that there were 36 experimental units. Each experiment consisted of 8 seeds, so the number of seeds used was 288 takka seeds. The data obtained were analyzed by F test using the SAS (Statistical Analysis System) program and if it had a statistically significant effect (at $\alpha = 5\%$), further tests were conducted using Duncan Multiple Range Test (DMRT)

The experimental design model used is as follows: (14)
 $Y_{ijk} = \mu + \rho_k + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \gamma_{ik} + \epsilon_{ijk}$ (1)

B. Observation

Observations will be made at the time of the start of drought stress treatment, namely when the seedlings are two months old and for subsequent observations carried out at intervals of two weeks until the seeds are ten months old. Observations were made on morphological responses which included plant height, leaf thickness, number of stomata, tuber wet weight, leaf dry weight, tuber dry weight, tuber diameter, stem diameter.

III. RESULTS AND DISCUSSION

Table 1 shows that the seed water content of each population, G2 (Gurua) population was higher at 8.54%, followed by G1 population (Gorango) at 8.23% and G3 population (Beksili) which had lower seed moisture content at 7.84 %. The seed germination capacity used in the study reached 100% for the Gurua and Gorango populations, while the Beksili population had a germination capacity of 80%.

Table 1. Seed moisture content, germination rate and seedling height of the takka population (*Tacca leontopetaloides* L.) used in research

Population	Seed moisture content (%)	Germination (%)	Seed height (cm)
G1 (Gorango)	8.23	100	14
G2 (Gurua)	8.54	100	15
G3 (Beksili)	7.84	80	14

A. Effect of treatment on observed variables

Table 2. Recapitulation of various influences of media water content and genotype on the morphology of the takka plant (*Tacca leontopetaloides* L.) at the end of the observation

Variable	MWC	Genotype	MWC x Genotype
Plant height	**	tn	tn
Leaf thickness	**	tn	tn
Rd diameter	**	**	**
Dry leaf weight	**	**	**
The number of tubers and shoots	**	tn	tn
Tuber diameter	**	**	**
Fresh tuber weight	**	**	**
Dry tuber weight	**	**	**

Explanation: * = real, ** = very real, ^{tn} = not real

The observations showed that the water content of the media significantly affected plant height, leaf thickness, number of stomata, tuber wet weight, leaf dry weight, tuber dry weight, tuber diameter, stem diameter (Table 2).

B. Effect of Water Stress on Growth of Takka Plants

Morphological effects of plants observed were plant height, leaf thickness, number of stomata, leaf water content, tuber wet weight, tuber dry weight, tuber diameter, stem diameter, number of tubers and number of shoots.

1) Plant height

Plant height as a growth parameter can be seen from changes in environmental factors such as light and water. The effect of plant height is significantly affected by a single factor of drought stress.

Table 3. Effect of media water content (MWC) on plant height (cm) takka at the end of the observation.

Treatment	Middle Value
K1 (MWC 100%)	44,51 a
K2 (MWC 75%)	40,97 b
K3 (MWC 50%)	39,83 b
K4 (MWC 25%)	33,9 c

Explanation: Figures followed by the same letters are not significantly different at the 5% DMRT level

Table 3 shows that the treatment of drought stress decreases the media water content from 100% to 75% has a very real effect. A decrease of 75% to 50% had no significant effect, while at the time of stressing 50% to 25% had a very significant effect on plant growth. Plant height at 75% media water content decreased 10.64 cm, followed by 50% media water content that is 3.4 cm and the lowest 25% media water content around 17.81 cm. [15] that the height of corn plants decreases when given water stress treatment. The same thing was also done (16) that the decrease in media water content in drought also caused plant height to be lower by around 22.43%.

The highest plant height was found in the treatment of 100% water content, so that cell division, enlargement and elongation went well. Giving the treatment of 25% water content media has the lowest plant height, this causes the enlargement and elongation of cells inhibited. [17] that the height of lanang bambang seedlings decreased significantly with increasing water stress (KL 25%). One consequence of drought stress in plants is growth inhibition (8).

2) Leaf thickness

Increased leaf thickness is a form of plant growth. Leaf thickness response is strongly influenced by the interaction of media water content. The media water content of 100% was not significantly different from the media water content of 75%, 50% and 25%. However, the moisture content of the media is 25% thicker around 1.39 mm.

Table 4. Effect of media water content on leaf thickness (mm) of takka at the end of the observation.

Treatment	Middle Value
K1 (MWC 100%)	1,03
K2 (MWC 75%)	1,08
K3 (MWC 50%)	1,15
K4 (MWC 25%)	1,39

Explanation: Figures followed by the same letters are not significantly different at the 5% DMRT level

Decreasing the moisture content by 25% can increase leaf thickness, this is one of the structural defense mechanisms found in plants to maintain leaf water content. [7] Application of plant growth regulating leaves, both natural and synthetic, has been shown to be beneficial for increasing growth against various abiotic pressures. Drought stress inhibits the increase in hypocotyl length and fresh weight.

3) Dry leaf weight

The dry weight of the leaves is influenced by a single factor of media water content (Table 5).

Table 5. Effect of media water content (MWC) on the dry weight (g) of takka plants at the end of the observation

Treatment	Middle Value
K1 (MWC 100%)	47,45
K2 (MWC 75%)	37,86
K3 (MWC 50%)	36,83
K4 (MWC 25%)	33,66

Explanation: Figures followed by the same letters are not significantly different at the 5% DMRT level

The results of table 5 analysis showed that the dry weight of the leaves treated by media water content was not significantly different, but a decrease in the media moisture content of 25% gave lower results than 100% media water content, followed by 50% and 75%. This is consistent with research conducted [18] that the application of drought stress at 40% field capacity gives a dry weight yield of around 10.26g.

The treatment of drought stress levels is lower causing a decrease in dry weight. Lack of water decreases vegetative development and crop yields through leaves thereby reducing photosynthesis.

4) Rod diameter

The stem diameter of the takka plant did not have a significant effect on the water content of the media and genotype (Table 6).

Table 6 shows that the treatment of a 25% decrease in water content gave a significant effect on stem diameter and was lower than the 50%, 75% and 100% media moisture content. In accordance with research [19] that lack of water will interfere with physiological and morphological activities, resulting in the cessation of growth. This is presumably due to the lack of water

available to plants causing a decrease in the rate of photosynthesis which results in at least asimilat scattered throughout the plant.

Table 6. Effect of media water content on stem diameter (mm) of takka plants at the end of the observation

Treatment	Middle Value
K1 (MWC 100%)	2,69
K2 (MWC 75%)	2,39
K3 (MWC 50%)	2,06
K4 (MWC 25%)	1,39

Explanation: Figures followed by the same letters are not significantly different at the 5% DMRT level

5) The number of tubers and shoots

Takka plant has one leaf number, if the number of leaves is one, it indicates that the number of tubers in it is also one. The number of tubers and shoots of takka plants is influenced by a single factor of media water content (Table 7).

Table 7. Effect of media moisture content on the number of tubers and shoots of takka plants at the end of the observation

Treatment	Middle Value
K1 (MWC 100%)	18 c
K2 (MWC 75%)	18,2 c
K3 (MWC 50%)	21,6 b
K4 (MWC 25%)	23,6 a

Explanation: Figures followed by the same letters are not significantly different at the 5% DMRT level

The results of table 7 analysis show that the number of tubers and shoots is significantly affected by a single factor of drought stress. The decrease in the media moisture content of 25% has a very significant effect compared to giving media water content of 50%, 75% and 100%. Giving 25% of media water content increases the number of tubers and shoots more (23.6) which is significantly different from the results obtained from giving 50% media water content. Obtained at 100% media water content treatment that is 18 which is not significantly different from 75% media water content treatment around 18.2.

The results of the analysis showed that the number of tubers produced on takka plants was influenced by the number of shoots. [20] that the number of tubers produced is related to the number of shoots formed. Decrease in moisture content of the media by 25% results in a higher number of shoots and tubers, related to plant resistance in times of water shortages. [21] that giving a 20% moisture content increases the dry weight of roots compared to giving a 50% moisture content

Provision of 100% media water content shows the lowest number of tubers and shoots, but has larger tuber and shoot sizes, this is presumably because the plants do not

experience stress so the photosynthesis process gets better. [22] that the leaves formed grow bigger and wider can increase the rate of photosynthesis. [23], the formation of tubers is seen from the swelling and enlargement of the tubers as a result of the process of cell division and enlargement of cells that function as new storage cells.

6) Tuber diameter

Table 8 shows that the effect of plant height was significantly affected by a single factor of drought stress.

Table 8. Effect of media water content on tuber diameter (mm) of takka plants at the end of the observation

Treatment	Middle Value
K1 (MWC 100%)	35.20 a
K2 (MWC 75%)	30.82 b
K3 (MWC 50%)	24.00 c
K4 (MWC 25%)	16.69 d

Explanation: Figures followed by the same letters are not significantly different at the 5% DMRT level

Table 8 shows that the treatment of giving water content of 100% media gives a larger diameter of the tubers and is very significantly different from the giving of water content of media 25%, 50% and 75%. The smallest diameter of the tuber is found in a 25% decrease in water content. [16] that applying drought stress to sweet potatoes can reduce the diameter of about 1.43 - 3.06 cm. This is presumably due to the lack of water available to plants causing a decrease in the rate of photosynthesis which results in at least asimilat scattered throughout the plant.

That the administration of a 100ml concentration of biourine produced the highest tuber diameter (25.44 mm) [24], compared to the administration of a 50ml concentration of biourine producing the lowest diameter of 21.03 mm, which was not significantly different from the B2 treatment (concentration of 50 ml), namely 21.24 mm.

7) Fresh tuber weight

Table 9 shows that the response of fresh tuber weights is influenced by a single factor of drought stress.

Table 9. Effect of media water content on fresh tuber weight (g) of takka plants at the end of the observation

Treatment	Middle Value
K1 (MWC 100%)	244.49 a
K2 (MWC 75%)	164.99 b
K3 (MWC 50%)	113,02 c
K4 (MWC 25%)	105,28 d

Explanation: Figures followed by the same letters are not significantly different at the 5% DMRT level

The application of water stress to the weight of fresh tubers at 100% media water content has a very significant effect compared to 75%, 50% and 25% media water content, respectively. The weight of fresh tubers in media

water content decreased 75% by about 79.5%. Decreased again when giving 50% media water content that is 51.97%. The lowest decrease in media moisture content is found in the media moisture content of 25%, which is 7.92%. The same thing was said [16] that the sweet potatoes that were given a drought stress could reduce the weight of dried sweet potatoes by around 70.35%.

That plants experiencing stress will provide a small supply of water to the roots, so as to reduce the weight of sweet potatoes per plant, around 88.68% [8].

The fresh weight of plants is used to determine the ability of plants to absorb water. Water content in the soil and the ability of roots to absorb water greatly affect the amount of water absorbed by the roots

8) Dry tuber weight

Table 10 shows that the effect of plant height was significantly affected by a single factor of drought stress.

Table 10. Effect of media moisture content on dry tuber weight (g) of takka plants at the end of the observation

Treatment	Middle Value
K1 (MWC 100%)	177.70 a
K2 (MWC 75%)	108.96 b
K3 (MWC 50%)	83.99 c
K4 (MWC 25%)	78.74 d

Explanation: Figures followed by the same letters are not significantly different at the 5% DMRT level

Decreased water content of the media from 100% to 75% and is very real when giving stress 50% to 25%. Plant height at 75% media water content decreased 10.64 cm, followed by 50% media water content which was 3.4cm and 25% media water content around 17.81 cm.

Plant dry weight is a measure of weight that is often used to determine plant biomass. Dry weight is the weight of plants that have been eliminated by water drying [25].

IV. CONCLUSION

Based on the above problems, a conclusion can be drawn, namely: The treatment of drought stress at 100% and 75% water content has a significant effect on the treatment of plant height, dry leaf weight, stem diameter, fresh tuber weight, dry tuber weight, tuber diameter. Provision of 25% media water content has a significant effect on the number of tubers and number of shoots (23.6), whereas in giving 100% the lowest tuber count is around 18 but does not have a significant effect on fresh tuber weight and dry tuber weight. The treatment of drought stress did not have a significant effect on the interaction between genotype and media water content on parameters of plant height, leaf thickness, number of shoots and tubers.

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REFERENCES

- [1] T. I. Borokini, A. E. Ayodele. Phytochemical Screening of *Tacca Leontopetaloides* (L.) Kuntze Collected from Four Geographical Locations in Nigeria. *International Journal of Modern Botany* 2012, 2(4): 97-102
- [2] I. Norscia, T. S. M. Borgognini. Ethnobotanical Reputation of Plant Species From Two Forest of Madagascar A Preliminary Investigation. *South African Journal of Botany* 72 (2006) 656–660
- [3] U. J. Ukpabi, E. Ukenya and A. O. Olejede. Raw-Material Potentials of Nigerian wild Polynesian Arrowroot (*Tacca leontopetaloides*) Tubers and starch. *Journal of Food Technology* 2009, 7(4), 135-138
- [4] I. Ahmad, Z. B. Arina. Antimicrobial and phytochemical studies on 45 Indian medicinal plants against multi-drug resistant human pathogens. 2001.
- [5] J. R. Hanson, *Natural Products: The Secondary Metabolites. University of Sussex*, 2011.
- [6] S. D. Setyorini and E. Yusnawan, 2016. The Increase of Secondary Metabolite in Legumes as a Response of Biotic Stress
- [7] M. A. Farooq, N. Wahid, D. Kobayashi, S. M. A Fujita and Basra. Plant drought stress: effects, mechanisms and management. *Agron. Sustain. Dev.* 29 (2009) 185–212 c INRA, EDP Sciences, 2008
- [8] S. Y. S. Lisar, R. Motafakkerazad, M. M. Hossain and I. M. M. Rahman. *Water Stress in Plants: Causes, Effects and Responses*. Januari, 2012.
- [9] G. J. Sanders, S. K. Arndt. *Osmotic Adjustment Under Drought Conditions. Plant Responses to Drought Stress*. Chapter, 2012.
- [10] E. C. Silva, R. J. M. C. Nogueira, M. A. Silva and M. B. Albuquerque. *Drought Stress and Plant Nutrition*. Plant Stress ©2011 Global Science Books
- [11] Mostajeran and V. Rahimi-Eichi. Effects of Drought Stress on Growth and Yield of Rice (*Oryza sativa* L.) Cultivars and Accumulation of Proline and Soluble Sugars in Sheath and Blades of Their Different Ages Leaves. *American-Eurasian J. Agric. & Environ. Sci.*, 2009. 5 (2): 264-272, ISSN 1818-6769
- [12] B. Valliyodan, H. T. Nguyen. Understanding regulatory networks and engineering for enhanced drought tolerance in plants. *Current Opinion in Plant Biology*. Elsevier. 2006. 9(2): 189-195.
- [13] W. Larcher, *Physiological Plant Ecology* (4rd Edn), Rima, São Carlos, 550 pp. 2006.
- [14] D. Hardiyantoro. *Randomize Complete Block Design*. Laboratorium Ilmu Tanah. Jurusan Ilmu Tanah Fakultas Pertanian. Universitas Padjajaran. 2013.
- [15] H. Sinay. Effect of Drought Stress Treatment Towards Growth and Proline Content at The Vegetative Phase of Few Local Corn Cultivars From Kisar Island Maluku Under Green House Condition. *Prosiding Seminar Nasional Pendidikan Biologi*, Malang, 21 Maret 2015.
- [16] T. Handayani, Kusmana dan Helmi Kurniawan, 2018. Response and Selection of Potato Plants to Drought. *J. Hort.* Vol. 28 No. 2, Desember 2018.
- [17] Y. Bramasto, E. Rustam, Megawati, N. Mindawati. Growth Respon of Bambang Lanang Seedling (*Michelia champaca* L.) to Stress Condition. *Jurnal Penelitian Hutan Tanaman* Vol. 12 No. 3, Desember 2015, 211-221 ISSN: 1829-6327; E-ISSN: 2442-8930
- [18] I. F. Faradisa, B. Sukowardojo, G. Subroto. Effect of Drought Stress on yields and Physiological Quality of Two Seed Varieties of Soybean (*Glycine max* L. Merr.). *Agritrop Jurnal Ilmu-Ilmu Pertanian*. 2013
- [19] A. L. Gamez, D. Soba, A. M. Zamarreno, J. M. G. Mina, I. Arajuelo and F. Morales. Effect of Water Stress during Grain Filling on Yield, Quality and Physiological Traits of Illpa and Rainbow Quinoa (*Chenopodium quinoa* Willd.) Cultivars, *Plants*, MDPI, Article, 2019.
- [20] Y. Sufyati, A. K. S. Imran AK and Fikrinda. The Influence of Physical size and Number of Bulbs Per Hole on Growth and Yield of Shallot (*Allium ascalonicum* L.). *J.Floratek*, 2006; 2 : 43 – 54
- [21] U. Nugroho, N. Ermawati, R. A. Syaban. The Effectiveness Test of Bulb Size and Biourine Additions on the Growth and Yield oh Onion (*Allium ascalonicum* L.). *Agriprima, Journal of Applied Agricultural Sciences*. September, 2017 Online version : <https://agriprima.polije.ac.id> Vol. 1, No. 2, Hal. 129-138 P-ISSN : 2549-2934 | E-ISSN : 2549-2942.