The Effect of Water Availability on The Growth and Yield of *Kumis kucing* (*Orthosiphon aristatus* (Blume) Miq.)

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Abstract. *Kumis kucing* (*Orthosiphon aristatus* (Blume) Miq.) is one of the medicinal plants that are economically valuable because of the secondary metabolite of *sinensetin* efficacious for various diseases. Growth and yield the plants are affected by environmental factors, one of which is water availability. The aim of the research was to evaluate the effect of water availability on growth and yield of *kumis kucing*. The design of the study was a complete randomized design with a single factor, which was water availability (100; 50; 37.5; 25 and 12.5% field capacity/FC). Data observation was analyzed by analysis of variance and followed by the Duncan Multiple Range Test at 5% upon the significant result. The result showed that the water availability 50-12.5% FC had a negative effect on plant growth, dry weight, and fresh weight of the plant, whereas the highest growth reduction occurred at 12.5% FC on height plant, leaf area, dry weight, and fresh weight of the plant. The result showed that *kumis kucing* is a plant that is resistant to low water availability.

Keywords: Growth, Medicinal Plant, Water Availability, Yield.

1. Introduction

The plant of *kumis kucing* (*Orthosiphon aristatus* (Blume) Miq.) is one of the herbal medicinal plants belonging to the Lamiaceae family. *Kumis kucing* contains high potassium so that it is diuretic, phenolic compounds, and enough terpenes [1]. *Kumis kucing* to treat a variety of ailments, like edema, hepatitis, jaundice, hypertension, influenza [2], rheumatism, prevention, and treatment of diabetes [3]. Besides *kumis kucing* is also used as an anti-inflammatory, antioxidant, anti-microbial, analgesic, and anti-hypertension [4]. The use of *kumis kucing* as traditional medicine is widely known to foreign countries because it can treat various diseases [5]. Ethyl acetate extract of the *kumis kucing* can inhibit pathogenic bacteria (*Pseudomonas aeruginosa*, *Aeromonas hydrophilla*, *Staphylococcus aureus*) and colon cancer cells [6]. Methanol leaf extract of the *kumis kucing* produces high antioxidant levels and is not toxic [7].

One of the influential environmental factors in plant cultivation is water availability. Water availability has excellent effects on plant growth. Lack of water in plants, followed by reduced water in the area of rooting, will cause the unequal physiological process of the plant. The ability of plants to face the availability of waterless or water shortage is with tolerance to the condition. The shape of crop tolerance to water shortage condition decreases in crop height and leaf size to reduce water loss. The results of [8] expressed a significant drought in reducing the growth and productivity of *Brassica rapa*.

In general, drought will affect crop growth in the form of changes in physiology and anatomy. Drought effect causes reduced soil moisture, thereby affecting the cycle occurring in the body of plants [9]. Drought stress also leads to decreased photosynthesis speed and leaf area [10]. The effect...
of drought causes the lower the photosynthesis and transpiration rate, stomatal conductance and growth [11]. Drought stress will not have a big impact, while the level of the drought is detected at a tolerable level [12]. In the drought condition of plants nyamplung experiencing morphological changes, anatomy, and physiology in the form of a decrease in plant height, stem diameter, number of leaves, leaf area, total dry weight [13]. Drought stress causes reduced production of dry matter, index of leaf area, number of seeds per plant, hundred seed weight, and grain yield [14].

Water stress causes the loss of crops based on the severity and duration of stress experienced. The presence of water in the plant has a change in the resistance mechanisms in both morphologically, physiological, and molecular. Drought stress reduced leaf size, stem extension, and root proliferation, disturb plant water relations, and reduces water use efficiency. Plant tolerance to drought can be managed by mass screening and breeding, marker-assisted selection, and exogenous application of hormones and osmoprotectants to seed or growing plants, as well as engineering for drought resistance [15].

Drought stress affecting the morphology of plants also affects the yield of barley plants [16]. Drought stress causes high growth of the plant is stunted due to decreased cell enlargement and more leaf aging in A. esculentus [17]. Water stress negatively affects the character morpho-physiological rice plants but the level of resilience any plant different depending on the level of stress and genotypes [18].

Tolerance to abiotic stress is very tricky because of the complicated interactions between stress factors and various molecular, biochemical, and physiological phenomena affecting plant growth and development [19]. Understanding the plant's response to drought is of paramount importance and is also a fundamental part of making plants more tolerant [20]. This research is essential to know the effect and adaptability of the *kumis kucing* that is grown in conditions with limited water availability.

### 2. Research Method

The research was conducted from August to October 2019 in the greenhouse Faculty of Agriculture, University of Kadiri, Kediri, East Java. The study used a Completely Randomized Design (CRD) consisting of one treatment factor with three replications in each treatment. The element was water availability, categorized into five levels of water conditions, namely 50, 37.5, 25, and 12.5% field capacity (FC). Data were analyzed using variance analysis, and the analysis was followed by DMRT (Duncan Multiple Range Test) 5% when the results were significantly different.

The planting materials used were *kumis kucing* cutting (25 cm long). Maintenance of the plant before the treatment is watering every day as much as 100% FC on each polybag. FC is determined by weighing soil 8 kg in a polybag as the initial weight. The polybag is inserted into the bucket filled with water and let it cover the ground surface. After that, the polybag is stored for 3-4 days until the water does not drip and weighed as the final weight. The difference between the initial weight and the final weight is a large capacity.

After the *kumis kucing* is 4 weeks old, watering based on treatment is 100; 50; 37.5; 25 and 12.5% FC up to harvest. *Kumis kucing* is gathered at the age of 3 months. Variable observations are plant height, leaf area, fresh weight, and dry weight of the plant. Plant height measurements were carried out by measuring plants from the base of the stem to the highest end of the leaf using a ruler. The fresh weight calculation of the plants was done by taking the plants, washing them to remove the remaining soil, and then weighing them using a digital analytic scale. The dry weight calculation of the plants was done by taking the plants, cleaning them to remove the remaining soil, and dried using for 24 hours at 80°C.

### 3. Result and Discussion

Water availability is one of the main factors for the growth and development of a plant. When the growth and development of plants are not available, water affects the physiological process of the plant resulting in stunted plant and low yield—water availability of real effect to height plants of *kumis kucing* (table 1). Plants with water availability 100% FC every day, growth is good with a
standard plant, the height reaches 77.7 cm². Plants with water availability 50-12.5% FC, growth is hampered but inter treatment is no significant effect. Plants that have water availability from 50; 37.5 and 25% of FC have a height of 67.3; 60 and 50 cm. The largest reduction of growth in plants with water availability is 12.5% FC where abnormal growth (height 41.3 cm) and wither.

The shortage of water in plants is directly resulting in decreased cleavage and magnification of cells. Lack of water will decrease the growth in diameter and height of plants due to the decline in turgor pressure. Disruption of water flow from xylem to elongated cells resulting in the extension of the cell [11] and hamper of mitosis and cell enlargement [16].

Table 1. Analysis of variance for *kumis kucing* main treats water availability

| Source of Variance | df | Plant Height | Leaf Area | Dry Weight of Plant | Fresh Weight of Plant |
|-------------------|----|--------------|-----------|--------------------|-----------------------|
| Treatment         | 4  | 459.933*     | 245465.833* | 1060.733*         | 31694.733*            |
| Error             | 10 | 31.200       | 16299.667  | 32.200             | 541.000               |
| R²                |    | 0.848        | 0.767     | 0.844              | 0.860                 |

*Significant at 0.05% level, R²: coefficient of determination

Water availability levels significantly affect the leaf area. The leaf area of the plant with water availability 100% FC is wider, whereas in plants with water availability, 50-12.5% FC is narrower and smaller. Plants with water availability are 12.5% FC have the lowest leaf area is 280.67 cm². The leaf area decreases in line with the lower availability of water (table 1). The leaf area is a very important growth parameter associated with the photosynthesis process. Plants that have a large leaf area, the photosynthesis process is also great. Drought stress (water deficit) largely reduces leaf growth and, in turn leaf area on many plant species such as *Populus* [21], *soy* [22].

Table 2. The effect of water availability on plant height (cm) *kumis kucing*

| Water Availability Level | Plant Height | Leaf Area | Dry Weight of Plant | Fresh Weight of Plant |
|--------------------------|--------------|-----------|--------------------|-----------------------|
| 100% FC                  | 77.7d        | 1946.30d  | 60.3d              | 310.0d                |
| 50% FC                   | 67.3c        | 823.33c   | 36.6c              | 174.3c                |
| 37.5% FC                 | 60.0bc       | 677.00bc  | 24.6b              | 114.6b                |
| 25% FC                   | 54.0ab       | 527.67b   | 20.0ab             | 84.0ab                |
| 12.5% FC                 | 41.3a        | 280.67a   | 12.0a              | 47.3a                 |

Note: Numbers that are followed by the same letters in the same column are not significantly different at the 5% level of significance in the Duncan Multiple Range Test (DMRT).

Drought stress-causing stunted plant growth because water availability in plants and soil affects the absorption of soil nutrients by plants root. Growth is capable of being achieved through cleavage, enlargement, and differentiation of cells, and involves genetic, physiological, ecological, morphological, and complex interactions. The quality and quantity of growth depend on the activity that occurs on the body of plants is affected by water availability of the plant.

Production of dry matter one of the variables is important to estimate the production of the potential plant. The dry weight of plants is affected by water availability levels (table 1). Water availability levels of 50-12.5% FC produces lower plant dry weight compared to water availability of 100% FC. The lower water availability is causing, the lower dry weight of the plant. The dry weight of the plant whose water availability is 37.5-12.5% FC does not show any noticeable difference. Likely because the difference in water availability level is relatively small so that the dry weight produced is not much different. The dry weight of plants whose water availability 37.5% FC is 24.6 gr while the
dry weight of plants with 25% FC is 20.0 gr. The plant on water availability 12.5% FC produces the lowest dry weight of 12.0 gr. While in the plant whose water availability 37.5% FC and 50% FC is no different from the real, it is possible because the plant on water availability 37.5% FC is still a tolerance to the side so that the weight of the base does not indicate a difference. Water deficit on plants caused the reduction of fresh and dried biomass production [2]. Plant productivity under drought stress is strongly linked to the process of partitioning dry materials and the distribution of temporal biomass [23].

4. Conclusion
The water availability 50-12.5% FC had a negative effect on plant growth and result, whereas the highest growth and yield reduction occurred at 12.5% FC on height plant, leaf area, dry weight and fresh weight of the plant. The result showed that kumis kucing is a plant that is resistant to low water availability.

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