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Effect of Alkaline and Drought Stress on Growth and SOD Content in Basil Plant (*Ocimum americanum*)

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Abstract. *Basil plant (Ocimum americanum) is a fragrant annual plant widely cultivated by the people in Indonesia because it is useful and commercial. Previous research on salinity and drought stress affect basil growth and development, cell turgor pressure, and the anatomical structure of the plant. However, research on the effect of alkalinity and drought stress in basil plants has not been carried out. Therefore, this study was conducted to determine the effect of variations in alkaline and drought stress on the growth and superoxide dismutase (SOD) content of basil plants. Alkalinity stress was carried out by variations of dolomite (D) doses, namely D1, D2, D3, and D4 (0 grams/pot, 100 grams/pot, 150 grams/pot, and 200 grams/pot) and variations of drought stress, namely A1, A2, A3, and A4 (25%, 50%, 75%, and 100% of field capacity). Parameters measured were plant height, leaf length and width, number of leaves, fresh and dry weight, SOD content, and environmental parameters. The growth of the basil plant (O. americanum) decreased after being given drought stress at the field capacity level 25%, while the SOD content produced was influenced by the treatment that given and increased by 1.02% at the highest level of alkalinity and drought stress.*

Keywords: *dolomite, drought, stress, Ocimum americanum, superoxide dismutase*

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INTRODUCTION

The basil plant (*O. americanum*) is a fragrant beverage plant and an essential tropical herbaceous plant with a short (annual) life span. The distribution of the basil plant covers the region of Asia, Africa, as well as Central and South America. Basil is also cultivated commercially in the continents of Southern Europe, Egypt, and California. In Indonesia, basil plants are commonly found and cultivated by the people of Java, Bali, and Sulawesi (Maghfoer et al., 2019).

Basil plants have benefits as antioxidants because they contain phenolic compounds, phenolic acids, and flavonoids. The essential oils found in this plant are generally in the form of camphor, citral, eugenol, linalyl acetate, and methyl chavicol (Çakmaçi & Milton 2019).

Plants have a certain response to environmental factors that affect their survival. Soil is one example of an environmental factor that has an important role in the survival of plants which can act as a planting medium that provides various kinds of nutrients, minerals, and water that are useful for plant survival. Each type of soil has a certain pH level depending on the state of the surrounding environment. Soil pH affects the supply and absorption of nutrients by plant roots. Nutrients are absorbed by plants through the root surface in the form of water and ion exchange (Handayanto et al., 2017).

Soils with a pH below 5.5 are more likely to have free Al which is toxic because it can inhibit the availability of phosphate. Meanwhile, soil with a pH above 7.5 (alkaline soil) can increase the CEC (Cation Exchange Capacity) of the soil, decrease the positive charge on the soil colloid, and the phosphate fixation process will be reduced (Utomo et al., 2016). The Cation Exchange Capacity (CEC) is the ability of the soil to absorb cations such as nutrients Ca, Mg, K, and other elements where isomorphic substitution occurs in the mineral structure by replacing one ion with another ion having the same size and type but different the number of charges (Munawar 2018).

Water availability is a factor that can affect the growth and development of basil plants. Reduced water availability causes abiotic stress so that it can affect the balance of productivity, especially in the production of secondary metabolites, as well as the physiological and anatomical structures of basil plants (Khakdan et al., 2017).

The mechanism of a plant's adaptation to different environmental conditions caused constant modification of the physiological and morphological conditions of the plant. As an example, the content of SOD in the *Rhizophora* sp. roots is high because of heavy metal exposure as a Cu stress response (Siswanti et al., 2016). To determine the effect of alkaline stress with different doses of dolomite and drought, it is necessary to research these two environmental factors treatment on basil plants so that results can be obtained regarding the growth and SOD content of basil plants under those stress. Research on alkaline stress and drought in basil plants has not been widely carried out. Research on environmental stresses in basil plants is mostly found regarding salinity and drought stresses that affect the growth and development of basil plants. Plants that experience drought and alkaline stress result in decreased plant growth and productivity. This is in line with the knowledge and research results obtained that drought stress has a significant effect on plant growth while the SOD content of the resulting plants has increased by 1.02% along with the increased alkaline stress given.

MATERIALS AND METHODS

Basil seeds (Benih Inti) used obtained from PT. The Dinasty Inti Agrosarana. The seeds were cultivated in small polybags containing nursery media. Each polybag contains 1-2 basil seeds. The seeds were then maintained for ± 25 days before being transferred to the treatment medium. Plant cultivation was maintained in the same field conditions in Klaten, Central Java, Indonesia while plant growth and SOD content measurement was carried out in the laboratory of Plant Physiology, Faculty of Biology, Universitas Gadjah Mada and the Laboratory of the Biotechnology Postgraduate Studies, Universitas Gadjah Mada, Yogyakarta in July-October 2021. The alkaline treatment was done by giving the dolomite lime with doses of 0 grams/pot, 100 grams/pot 150 grams/pot, and 200 grams/pot on the treatment media. Drought stress treatment was carried out by giving watering variations with levels of 25%, 50%, 75%, and 100% of field capacity on the treatment media 3 times a week for ±28 days. The research design used was a Factorial Completely Randomized Design (CRD) with five replications on each treatment. Measurement of plant growth parameters was carried out at the end of the treatment (after 28 days of treatment), including plant height, length and width of leaves, number of leaves, and also fresh and dry weight of treated plants. Measurement of the SOD content using the Pyrogallol Autooxidation method by Marklund & Marklund (1974). The content of SOD can be expressed in units/grams of protein, namely the content of one enzyme unit defined as the number of enzymes needed to produce 50% reaction inhibition. Quantitative data were analyzed by analysis of variance (ANOVA) at the 95% level to determine the effect of the treatment and continued with the Duncan Multiple Range Test (DMRT) at the 95% level if there was a significant difference. The data analysis was carried out using SPSS 25 software.

RESULTS AND DISCUSSION

The soil temperature in the cultivated medium with the addition 0-200 gram/pot dose of dolomite was 29°C, which is different from the soil without the addition of dolomite of 28°C. However, both are still within the optimum temperature range required for basil plants to grow properly which is 25-30°C (Barickman et al. 2021). Likewise, for the parameters of soil moisture and pH between the treatments, there were differences in those parameters in the range of 47-100% humidity values and pH of 6.9-7. The basil plant was able to grow and develop because the range where basil plants can grow optimally, namely minimum soil moisture of 39.35% and pH tolerance of 4.3-8.2 (Maghfoer et al. 2019). The measured light intensity parameter was 36,850 lux, in this case, it is also included in the light intensity that is good for the growth of basil plants in full sun conditions (Table 1).

Results on Basil plant height after the combination of alkaline stress treatment with the addition of different field capacity (FC) level water volumes are shown in Table 2. According to research by Manurung et al. (2019) water has an important role in cell enlargement and elongation, regulation of cell turgor pressure, and active meristem tissue constituent in carrying out physiological processes in plants. Environmental conditions that are stressed by drought make plants respond by reducing growth and productivity. In addition, there was a reduction in nitrogen assimilation and cell water content due to decreased water absorption (Sarker & Oba, 2018).

The highest drought stress (25% field capacity) significantly affected plant height because the stress treatment was able to inhibit plant growth and development, and disturbed metabolic processes, resulting in poorer cell division and elongation compared to plants with adequate water treatment (Barickman et al. 2021). In this case, the water requirements needed by plants are sufficiently met so that they are able to support cell division and elongation as produce better plant growth.

The addition of dolomite according to the research of Putra et al. (2018) is one of the efforts that can be done in overcoming problems in peatlands to reduce its acidity. In this study, it was found that the addition of a high dose of dolomite was able to increase soil pH because dolomite lime contains Ca and Mg so that it can be hydrolyzed which results in broken Fe bonds and produces hydroxyl ions (OH-) which can increase soil pH and the Ca element has a role in cleavage cells and apical bud formation. Moreover, the addition of dolomite lime at a dose of 2-4 tons/ha according to Widodo (2000) in Putra et al. (2018) was able to increase soil pH by 1-2. Therefore, in this research, the addition of dolomite dosage variations of 100, 150, and 200 grams/pot at 75 to 100% water field capacity did not give the effect of alkaline stress on the growth of the basil plant even though the soil pH increased. This might be because the basil plant itself was able to survive and tolerant in the pH range of 4.3-8.2 and grows optimally at a soil pH of 5.5-6.5 (Anonymous 2012; Maghfoer et al. 2019).

The results in table 2 show that treatment of D4A4 (Dolomite 200 gr + 100% FC) was not significantly different from the treatment results of of D4A3 (Dolomite 200 gr + 75% FC), D3A3 (Dolomite 150 gr + 75% FC), D3A4 (Dolomite 150 gr + 100% FC), D2A3 (Dolomite 100 gr + 75% FC), and D2A4 (Dolomite 100 gr + 100% FC) on the height of the basil plant produced. This is because the addition of various doses of dolomite at the field capacity level of 75 and 100% did not have a significant effect on changes in pH, as shown in Table 1. The pH value of the soil after being given dolomite doses of 100, 150 and 200 grams/pot resulted in a similar pH value of 7 so that the resulting plant height was not significantly different in this treatment. This is possible because the level of dolomite given is not high enough. However, the administration of dolomite can still cause an increase in CEC (cation exchange capacity) in the soil due to changes in pH that occur as a result of the high exchanged base content (lime material) (Syachroni 2019).

Cation exchange capacity is the ability of the soil to absorb cations such as nutrients Ca, Mg, K and other elements. The increase in Ca and Mg elements in the soil can increase the formation of chlorophyll so that the growth process of basil plants can increase along with the increase in photosynthetic products (Munawar 2018 ; Putra et al. 2018).

Table 1. The environmental parameter during basil (*O. americanum*) harvest

Treatment	**Environmental Parameters**			
	Soil temperature	**Soil pH**	**Soil moisture**	**Light intensity**
A-D1	28°C	6.9	100%	36.850
A-D2	29°C	7	68%	36.850
A-D3	29°C	7	57%	36.850
A-D4	29°C	7	47%	36.850

Note: A-D1 : Variation in the level of field capacity + 0 gram/pot dose of dolomite, A-D2 : Variations in the level of field capacity + 100 grams/pot dose of dolomite, A-D3 : Variations in the level of field capacity + 150 grams/pot dose of dolomite A-D4 : Variation in the level of field capacity + 200 gram/pot dose of dolomite. *Measured at 10.30-13.00 WIB

Table 2. The effect of variations in dolomite doses at different levels of field capacity on the average plant height of basil (*O. americanum*)

Treatment	**Plant Height (cm)**
D1A1 (Dolomite 0 gr + 25% FC)	7.8 ± 1.71[a]
D1A2 (Dolomite 0 gr + 50% FC)	10.5±2.82[abcd]
D1A3 (Dolomite 0 gr + 75% FC)	12.1 ± 3.26[abcde]
D1A4 (Dolomite 0 gr + 100% FC)	12.0 ± 8.28[abcde]
D2A1 (Dolomite 100 gr + 25% FC)	8.2 ± 1.48[ab]
D2A2 (Dolomite 100 gr + 50% FC)	10.6 ± 0.82[abcde]

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Treatment	Plant Height (cm)
D2A3 (Dolomite 100 gr + 75% FC)	14.4 ± 2.01cde
D2A4 (Dolomite 100 gr + 100% FC)	15.1 ± 4.20cde
D3A1 (Dolomite 150 gr + 25% FC)	10.2 ± 1.75abc
D3A2 (Dolomite 150 gr + 50% FC)	10.2 ± 1.03abc
D3A3 (Dolomite 150 gr + 75% FC)	13.5 ± 7.79bcde
D3A4 (Dolomite 150 gr + 100% FC)	16.1 ± 0.96e
D4A1 (Dolomite 200 gr + 25% FC)	8.2 ± 1.60ab
D4A2 (Dolomite 200 gr + 50% FC)	10.8 ± 2.58abcde
D4A3 (Dolomite 200 gr + 75% FC)	14.7 ± 3.07cde
D4A4 (Dolomite 200 gr + 100% FC)	15.9 ± 4.68de

Values followed by the same letter in the same column indicate that there is no significant difference in the DMRT test with a 95% confidence level.

The results obtained from the treatment of varying doses of dolomite at different levels of field capacity on leaf length of the basil plant (*O. americanum*) based on Table 3 were significantly different based on the DMRT test with a 95% confidence level. Table 3. shows that the highest drought stress treatment (25% FC) produced the smallest average leaf length. Leaves are plant parts that have roles and responsibilities in efficient use of water. According to Forouzandeh et al. (2012) drought stress can reduce leaf area on basil plants. This is in line with the results obtained where all treatments with the highest level of drought stress (25% FC) produced the smallest average leaf length.

Dolomite treatment with field capacities of 75 and 100% produced good leaf length. Because in the treatment with these levels of field capacity, the volume of water provided is sufficient to meet and support the basil plant in carrying out leaf growth. In the process of leaf growth, there is a process of increasing the volume of expansive growth and increasing structural growth. The irreversible increase in leaf cell size requires large amounts of water to enter the vacuole. In addition, a substantial supply of carbon is needed as a building material for the structure of cellulose and hemicellulose as well as a source of fuel for various mechanisms that occur in cells (Pantin et al. 2012). In this case, leaf growth which is expansive increases in volume and requires cell turgor pressure controlled by enzymes followed by volumetric water flow required for leaf growth and the transpiration process (Pantin et al. 2012). Meanwhile, in this case pH affects leaf growth related to the absorption of Ca and Mg elements that support the process of chlorophyll formation and as a controlling factor for cation concentrations in leaves (Cornelissen et al. 2011).

The average leaf width of the basil plant (*O. americanum*) after being treated was not significantly different between treatments in the DMRT test with a level of 95% confidence (Table 3). This is because the possibility of treatment with various doses of dolomite at a given level of field capacity does not significantly affect the leaf width produced. The treatment of various doses of dolomite at a certain level of field capacity did not affect the leaf width of the basil plant because the leaf formation process involved two main phases, namely the activity of proliferation and expansion of leaf cells. Leaf size which in this case includes the resulting leaf width is influenced by ARGOS regulation which then regulates the action of DNA-binding proteins. In addition, there are growth-regulating factors (GFR) and TCP transcription factors as important regulators in leaf growth (Kalve et al. 2014).

Therefore, in this case, the leaf width produced after being treated with various doses of dolomite and a certain level of field capacity did not differ significantly. It was due to the smaller size of the basil leaf compared to the leaves of corn plants those with fan cells inside to stretch. However, in the process of leaf formation field capacity still affected the expansion and development of the leaf (Anggraini et al. 2015).

Table 3. The effect of variations of dolomite doses at different levels of field capacity on the average leaf width and leaf length of basil (*O. americanum)*

Treatment	Leaf Width (cm)	Leaf Width (cm)
D1A1 (Dolomite 0 gr + 25% FC)	2.74 ± 0.27^{ab}	1.48 ± 0.14^{ab}
D1A2 (Dolomite 0 gr + 50% FC)	3.09 ± 0.86^{abcd}	1.66 ± 0.51^{ab}
D1A3 (Dolomite 0 gr + 75% FC)	3.49 ± 0.81^{abcd}	1.81 ± 0.47^{ab}
D1A4 (Dolomite 0 gr + 100% FC)	3.23 ± 1.99^{abcd}	1.72 ± 1.08^{ab}
D2A1 (Dolomite 100 gr + 25% FC)	2.53 ± 0.61^{a}	1.44 ± 0.36^{a}
D2A2 (Dolomite 100 gr + 50% FC)	3.14 ± 0.16^{abcd}	1.62 ± 0.10^{ab}
D2A3 (Dolomite 100 gr + 75% FC)	4.01 ±0.33^{bcd}	2.07 ± 0.23^{ab}
D2A4 (Dolomite 100 gr + 100% FC)	4.26 ± 0.88^{cd}	2.17 ± 0.44^{ab}
D3A1 (Dolomite 150 gr + 25% FC)	3.03 ± 0.72^{abcd}	1.62 ± 0.37^{ab}
D3A2 (Dolomite 150 gr + 50% FC)	3.22 ± 0.23^{abcd}	1.78 ± 0.12^{ab}
D3A3 (Dolomite 150 gr + 75% FC)	3.53 ± 2.06^{abcd}	1.81 ± 1.06^{ab}
D3A4 (Dolomite 150 gr + 100% FC)	4.39 ± 0.37^{d}	2.22 ± 0.25^{b}
D4A1 (Dolomite 200 gr + 25% FC)	2.71 ± 0.45^{ab}	1.61 ± 0.08^{ab}
D4A2 (Dolomite 200 gr + 50% FC)	2.88 ± 1.15^{abc}	1.55 ± 0.69^{ab}
D4A3 (Dolomite 200 gr + 75% FC)	4.02 ± 0.38^{bcd}	2.12 ± 0.31^{ab}
D4A4 (Dolomite 200 gr + 100% FC)	4.26 ± 0.61^{cd}	2.14 ± 0.29^{ab}

Values followed by the same letter in the same column indicate that there is no significant difference in the DMRT test with a 95% confidence level.

According to the research of Sirousmehr et al. (2014), the highest number of leaves of basil plants was found in the 100% FC treatment (without stress) while the lowest number of leaves was shown in plants with the highest stress level (60% FC). In line with the research results of Sirousmehr et al. (2014) that obtained the results of the least number of leaves in the stress treatment of 25% FC. Reducing the number of leaves is one of the plant's efforts to reduce transpiration during drought stress.

The number of leaves produced by the basil plant is closely related to the field capacity levels of 75 and 100% (Table 4). This shows that water availability plays an important role in the sustainability of the plant transpiration process. The transpiration rate will increase with increasing watering volume. The increased transpiration rate will cause an increase in the rate of photosynthesis of plants because the opening and closing of stomata controlled by turgor pressure from guard cells and CO_2 diffusion runs better than in plants exposed to drought stress. If the stomata are closed, then CO_2 fixation will decrease and the gas exchange process will be inhibited. As a result, plants cannot carry out the photosynthesis process optimally to produce products as a source of plant energy in giving rise to new leaf shoots (Anggraini et al. 2015).

Table 4. The effect of variations of dolomite dosage at different levels of field capacity on the average number of leaves of basil (*O. americanum*)

Treatment	**Number of Leaves (Strands)**
D1A1 (Dolomite 0 gr + 25% FC)	7 ± 0.83[ab]
D1A2 (Dolomite 0 gr + 50% FC)	17 ± 9.20[abcde]
D1A3 (Dolomite 0 gr + 75% FC)	27 ± 15.29[def]
D1A4 (Dolomite 0 gr + 100% FC)	23 ± 17.54[bcdef]
D2A1 (Dolomite 100 gr + 25% FC)	5 ± 2.30[a]
D2A2 (Dolomite 100 gr + 50% FC)	16 ± 9.41[abcd]
D2A3 (Dolomite 100 gr + 75% FC)	27 ± 13.88[def]
D2A4 (Dolomite 100 gr + 100% FC)	33 ± 13.55[ef]
D3A1 (Dolomite 150 gr + 25% FC)	7 ± 2.40[ab]
D3A2 (Dolomite 150 gr + 50% FC)	15 ±8.04[abcd]
D3A3 (Dolomite 150 gr + 75% FC)	28 ± 17.68[def]
D3A4 (Dolomite 150 gr + 100% FC)	30 ± 4.20[def]
D4A1 (Dolomite 200 gr + 25% FC)	9 ± 4.21[abc]
D4A2 (Dolomite 200 gr + 50% FC)	19 ± 9.40[abcde]
D4A3 (Dolomite 200 gr + 75% FC)	25 ± 14.08[cdef]
D4A4 (Dolomite 200 gr + 100% FC)	36 ± 12.65[f]

Values followed by the same letter in the same column indicate that there is no significant difference in the DMRT test with a 95% confidence level.

Tables 5 Show the results of the treatment on the average fresh and dry weight of basil plants. The drought conditions or lack of water in large quantities have a significant effect on the fresh and dry weight of the basil plants produced as in the study of Manurung et al. (2019), that in the treatment of the lowest field capacity it was able to reduce cell turgor pressure and consequently inhibited cell growth. Water deficit is also able to reduce plant biomass (fresh and dry weight), growth, and development of *Ficus deltoidea* significantly. In this study, the dose of dolomite given did not provide enough alkaline stress to the affect biomass of basil plant produced as the basil plant was still able to grow and tolerate the pH occurred. At the field capacity level (100% FC), the available water is sufficient for plants to carry out photosynthesis which will then produce photosyntate to be used by plants as an energy source in elongating and dividing cells. Fresh weight is the result of the plant growth process, where the growth depends on cell division and enlargement and is closely related to the water content in the soil. In addition, at the 100% field capacity level, the frequency and volume of water were able to facilitate the transport of nutrients and biochemical processes as well as increasing cell turgidity that occurred in plants and indicated by the high fresh weight produced by the plant (Marsha et al. 2014).

The dry weight produced in this study was influenced by the level of field capacity in the given treatment, but not in the treatment without dolomite. Dry weight is the result of metabolic processes that occur in the plant body, which include the absorption of water and nutrients as well as the results of the photosynthesis process. The dry weight is the total biomass which indicates the productivity of a plant (Solichatun et al. 2005). In the treatment without dolomite, no Ca and Mg elements were added, therefore the dry weight produced in the control treatment was different from the treatment with the addition of dolomite. High amounts of Ca and Mg in soil media were able to stimulate cell turgor pressure, which in this case was able to increase plant productivity as indicated by the dry weight produced by basil plants.

Table 5. Effect of variations of dolomite dosage at different levels of field capacity on the average fresh and dry weight of basil (*O. americanum*)

Treatment	Fresh Weight (g)	Dry Weight (g)
D1A1 (Dolomite 0 gr + 25% FC)	0.26±0.06ᵃ	0.01±0.01ᵃ
D1A2 (Dolomite 0 gr + 50% FC)	0.93±0.43[ab]	0.08±0.09[abc]
D1A3 (Dolomite 0 gr + 75% FC)	0.87±1.01[ab]	0.13±0.12[bcd]
D1A4 (Dolomite 0 gr + 100% FC)	1.37±1.68[abc]	0.09±0.10[abc]
D2A1 (Dolomite 100 gr + 25% FC)	0.37±0.12[a]	0.02±0.00[a]
D2A2 (Dolomite 100 gr + 50% FC)	0.76±0.49[a]	0.06±0.04[ab]
D2A3 (Dolomite 100 gr + 75% FC)	1.15±0.75[ab]	0.11±0.10[abc]
D2A4 (Dolomite 100 gr + 100% FC)	1.90± 1.39[bc]	0.17±0.10[cd]
D3A1 (Dolomite 150 gr + 25% FC)	0.40±0.22[a]	0.04±0.02[ab]
D3A2 (Dolomite 150 gr + 50% FC)	0.75±0.31[a]	0.06±0.03[abc]
D3A3 (Dolomite 150 gr + 75% FC)	1.17±0.88[ab]	0.13±0.08[bcd]
D3A4 (Dolomite 150 gr + 100% FC)	1.89±0.37[bc]	0.22±0.07[d]
D4A1 (Dolomite 200 gr + 25% FC)	0.36±0.27[a]	0.04±0.03[ab]
D4A2 (Dolomite 200 gr + 50% FC)	0.79±0.51[a]	0.07±0.04[abc]
D4A3 (Dolomite 200 gr + 75% FC)	0.92±0.33[ab]	0.10±0.03[abc]
D4A4 (Dolomite 200 gr + 100% FC)	2.26±0.52[c]	0.21±0.07[d]

Values followed by the same letter in the same column indicate that there is no significant difference in the DMRT test with a 95% confidence level.

Based on the results obtained in this study, treatment with doses of dolomite at a high level of field capacity (200 grams/pot of dolomite at 75% FC) showed an increase in SOD content due to basil plants experiencing alkaline stress with chemical reactions between dolomite ($CaCO_3$) with water (H_2O) (Table 6). The reactions that occur are as follows (Handayanto et al. 2017):

$$CaCO_3 + H_2O\ Ca^{2+} + HCO_3^- + OH^{-.}$$

The reaction produces bicarbonate ions (HCO_3^-) which are base (alkaline). Giving dolomite to treatment media on the other hand is also able to increase soil pH because OH^- will neutralize the H^+ contained in the soil solution so that the planting medium becomes alkaline. Dolomite contains elements of Ca or Mg which will then combine with acid and neutralize it in the soil (Lestari et al. 2009; Putra et al. 2018). SOD (Superoxide dismutase) is a functional antioxidant enzyme produced by plants as a physiological defense strategy against ROS and free radicals as a result of biotic and abiotic stresses (Stephenie et al. 2020).

In this study, the measurement of SOD content was indicated due to stress because of dolomite treatment and drought. Reactive oxygen species (ROS) are required by cells to regulate cell proliferation, cell differentiation, and also as physiological response signaling molecules (Shen et al. 2018; Mesa-Herrera et al. 2019). The accumulation of excess ROS in plants can cause damage to proteins, cell membranes, RNA, and DNA which if not repaired will cause cell death. Therefore, control of ROS is needed so as not to damage plant cells (Zhang et al. 2017).

In this study, alkaline stress was more influential on the SOD activity produced by basil plants (*O. americanum*) than the given drought stress. SOD is one of the special mechanisms developed by plants to detoxify superoxide radicals and can be used as an index in detecting varieties with stress resistance, where plant genotypes that are more resistant producehigh SOD values in leaves according to research by Khayatnezhad & Gholamin (2021). In the research of Aziz et al. (2021) corn plants that were stressed due to stress showed a significantly increased SOD activity, in which case SOD played an important role in forming H_2O_2 in free radical dismutation.

The SOD content data produced in this study did not show significantly different results in various treatments and controls possibly due to differences in soil pH that occurred. The difference of pH not too much is probably caused by the administration of dolomite doses with a maximum of 200 grams/pot that does not increase the pH significantly because according to Widodo (2000) in Putra et al. (2018) soil pH will increase by 1-2 levels if given additional the dose of dolomite is 2-4 tons/ha so that the activity of the SOD enzyme as a defense mechanism against oxidative stress by superoxide free radicals is not significantly different.

Especially at the field capacity level of 75 and 100% where the volume of water given is more so that the possibility of dissolved lime content increases. The Ca^{2+} produced from the reaction between dolomite and water is able to replace the acidity in the soil (an increase in pH) but the Ca cations produced are still in a form that can be absorbed by plants. The correlation between SOD content with each parameter that was observed was in the general, if the plant experiences severe stress, the resulting SOD content tends to be high, along with a decrease in growth, the number of leaves, and plant wet and dry weight (negative or inversely correlated). However, in this study, the resulting SOD content tended to increase in the treatment with the highest alkaline stress level (200 grams/pot at 75% field capacity level) compared to the dolomite dose treatment at other field capacity levels, as well as growth, the number of leaves and the plant weights produced (positively correlated or directly proportional). This may be due to the tolerance level of the basil plant to changes in pH values that occur (the change in pH value is not too significant), therefore, even though the basil plant is experiencing alkaline stress as a result of the addition of dolomite at a certain dose (indicated by the resulting increase in SOD content) basil was still able to perform growth and development well (indicated by plant height, number of leaves and plant weight which was higher at this stress level). This can also because there are several parameters that affect the activity of the SOD enzyme, such as each tested plant organ, concentration, and time of exposure to stress (Szollosi, 2014).

Table 6. The effect of variations of dolomite doses at different levels of field capacity on the average dry weight of basil (*O.americanum*)

Treatment	SOD Content (u/mL)
D1A1 (Dolomite 0 gr + 25% FC)	1.27±1.96[abc]
D1A2 (Dolomite 0 gr + 50% FC)	2.16±2.18[abc]
D1A3 (Dolomite 0 gr + 75% FC)	0.73±0.74[ab]
D1A4 (Dolomite 0 gr + 100% FC)	1.70±1.48[abc]
D2A1 (Dolomite 100 gr + 25% FC)	0.39±0.25[a]
D2A2 (Dolomite 100 gr + 50% FC)	2.06±1.61[abc]
D2A3 (Dolomite 100 gr + 75% FC)	1.58±0.89[abc]
D2A4 (Dolomite 100 gr + 100% FC)	2.77±1.01[abc]
D3A1 (Dolomite 150 gr + 25% FC)	1.41±0.91[abc]
D3A2 (Dolomite 150 gr + 50% FC)	2.31±2.23[abc]
D3A3 (Dolomite 150 gr + 75% FC)	2.80±0.67[abc]
D3A4 (Dolomite 150 gr + 100% FC)	3.33±0.33[c]
D4A1 (Dolomite 200 gr + 25% FC)	1.66±1.57[abc]
D4A2 (Dolomite 200 gr + 50% FC)	1.59±0.60[abc]
D4A3 (Dolomite 200 gr + 75% FC)	3.45±1.10[c]
D4A4 (Dolomite 200 gr + 100% FC)	3.09±0.45[bc]

Values followed by the same letter in the same column indicate that there is no significant difference in the DMRT test with a 95% confidence level.

CONCLUSION

The growth of the basil plant (*O. americanum*) decreased after being given drought stress at a field capacity level of 25%, while the SOD content of basil was influenced by the treatment given and increased by 1.02% at the highest level of alkalinity and drought stress

AUTHOR CONTRIBUTION

The contribution of each author in this research is Anindita Della Rosa Riyadi as the main author and Dwi Umi Siswanti as the second author as well as a supervisor who provides very useful suggestions and inputs in the continuation of this research.

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CONFLICT OF INTEREST

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