ABA Content of Palm Oil Seedlings (Elaeis guineensis Jacq.) with Vedagro Treatment on Water Stress

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Research Article

ABA Content of Palm Oil Seedlings (*Elaeis guineensis* Jacq.) with Vedagro Treatment on Water Stress

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Abstract

Background and Objective: Indonesia is one of the chief producers of palm oil of the world market, but all production is collected in one place. This research will include later whether there is a correlation between seedlings that are more adaptable of water stress in nurseries with field planting. This study was aimed to know the response of the growth of palm oil seedlings and ABA content to Vedagro fertilizer treatment and water stress. **Materials and Methods:** The experiment was conducted in the field experiment station of the Agricultural Faculty of Darma Agung University Medan, Indonesia, with ±28 meters above sea level. The research is done in May, 2019 until August, 2019. This research uses the Completely Randomized Block Design Factorial Method consisting of 2 treatment factors, that is Vedagro consists of 3 levels, $V_1 = 5.0$ g baby polybag^{-1}, $V_2 = 10.0$ g and $V_3 = 15.0$ g baby polybag^{-1} each, while water stress with 4 levels namely W0 = 0.2 L baby polybag^{-1} day^{-1}, $W_1 = 0.2$ L baby polybag^{-1} days^{-2}; $W_2 = 0.2$ L baby polybag^{-1} days^{-3}; $W_3 = 0.2$ L baby polybag^{-1} days^{-4}. **Results:** The results showed that the higher the dose of Vedagro, the higher the growth of seedlings, on the contrary, the lack of water cause the growth of seedling decreased but the ABA content increased. **Conclusion:** Vedagro up to 15 g baby polybag^{-1} increases significantly only to plant height. Water stress decreases significantly in plant growth but ABA content increase significantly 0.0022 ppm cm^{-2} leaf area.

Key words: Vedagro, water stress, growth, seedlings, ABA, biodiversity, seedling

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Indonesia always adheres to the constitution of the Republic of Indonesia to participate for the welfare of all the people and countries in the World, it is proven that Indonesia is one of the chief producers of oil palm has growth from 10.6 million ha in 2013 to 13.7 million ha by 2020[1] due to a ceaselessly growing demand[2], even though Indonesia often receive negative issues against the palm oil industry such as the destruction of forests and biodiversity, food security and agrarian conflicts and natural resources.

Tenera oil palm which is a Simalungun variety of North Sumatra is a reliable variety that can be grown in various regions in the country. Description of the Simalungun variety shown that it can grow in various regions and has high productivity, although it is assumed that productivity will be different in line with differences in rainfall or water adequacy. Unfortunately, Simalungun varieties after being planted in several regions in Indonesia, then companies or farmers harvesting, farmers collect and mix all fresh fruit bunches altogether means that all production is collected at one place so that they do not know the separation of each variety so the harvest is a collection of various varieties. This research will include later to solve the problem, one of them is whether there is a correlation between seedlings that are more adaptable of water stress in nurseries with field planting in various places in Indonesia where there are areas with low rainfall, moderate to areas of oil palm plantations with high rainfall. Morphological, physiological and biochemical characterization needs to be carried out at later research, in previous research showed that the impact of water deficit is young leaves not opening, broken old leaf midrib until broken[3].

Nowadays manure is very difficult to find and complicated, fertilizer Vedagro can replace it[4]. The need for water for oil palm seedlings in the pre-nursery is 0.2 L baby polybag^{-1} day^{-1}, so the watering below 0.2 L baby polybag^{-1} day^{-1} is considered to be water stress while in Malaysia watering 0.5 L polybag^{-1} day^{-1} in the pre-nursery because the polybag size is different[5-7]. From the results of previous studies, it is known that ABA is formed as a response to water deficits and it accumulates in all organs of the plant, is reported higher in leaves. In this regard, research needs to be done in the form of treatment of fertilizer Vedagro under conditions of water stress on the growth and development of oil palm seedlings (*Elaeis guineensis* Jacq). The purpose of this study was to know the growth of oil palm seedlings with Vedagro fertilizer treatment and ABA content due to lack of water.

MATERIALS AND METHODS

Study area: The experiment was conducted in the field experimental station of the Agricultural Faculty of Darma Agung University in Medan North Sumatera with ±28 m above sea level. This experiment uses Tenera oil palm seedlings variety of Simalungun which is obtained from the Indonesia Oil Palm Research Institute. Other material used is baby polybag, planting medium, which was carried out in a plastic house which is avoided of rainfall. The research is done in May, 2019 until August, 2019.

Methodology: The research procedure was started by filling baby polybag with planting media, then a week later planted oil palm seedlings and added with Vedagro fertilizer according to treatment, then the data collection was adjusted to the response variable which was observed, once every two weeks, starting at the age of the seedlings 4-12 weeks after planting. This experiment uses the Block Random Design Factorial Method consisting of 2 treatment factors. The first, Vedagro Fertilizer Dose consists of 3 levels, namely, V_1 = 5.0 g baby polybag^{-1}, V_2 = 10.0 g baby polybag^{-1}, V_3 = 15.0 g baby polybag^{-1}, while the second, water stress consisting of 4 levels namely W_0 = 0.2 L baby polybag^{-1} day^{-1}; W_1 = 0.2 L baby polybag^{-1} days^{-2}; W_2 = 0.2 L baby polybag^{-1} days^{-3}; W_3 = 0.2 L baby polybag^{-1} days^{-4}. The parameters were observed at ages 4-12 weeks after planting i.e., plant height, stem diameter, the number of leaves, leaf area and the ABA content.

Statistical analysis: Statistical analysis using variance analysis and if the treatment effect is significant, followed with the LSD test at the 5% level.

ABA content analysis is carried out following the procedure Laboratory of the Institute of Research and Development of Agriculture-Center for Research and Development of Agriculture Biotechnology and Genetic Resources of Agriculture, Bogor.

RESULTS

The results showed that plant height continued to increase with increasing plant age (Table 1). Although the effect of the combination treatment of Vedagro and Water Stress is not significant. However, the higher the dose of Vedagro fertilizer the higher the plant height was found, on the other hand, the less water the more depressed the growth of seedlings, Watering 0.2 L baby polybag^{-1} days^{-4} significantly reduces the height of oil palm seedlings as many 7.81 cm at 12 weeks after planting.

Table 1: Effect of Vedagro fertilizer and water stress treatment to plant height of palm oil seedlings at ages 4-12 Weeks After Planting (WAP)

	Plant height (cm)				
Treatments	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
V_1 = 5 g baby polybag^{-1}	9.12	12.66	15.35	18.36^{a}	21.54^{a}
V_2 = 10 g baby polybag^{-1}	9.84	13.51	16.22	19.18^{ab}	22.61^{b}
V_3 = 15 g baby polybag^{-1}	9.39	12.99	15.79	19.91^{b}	23.30^{c}
W_0 = 0.2 L baby polybag^{-1} days^{-1}	9.60	13.28	16.69	20.50^{a}	23.96^{a}
W_1 = 0.2 L baby polybag^{-1} days^{-2}	9.50	13.03	15.79	19.92^{a}	23.47^{a}
W_2 = 0.2 L baby polybag^{-1} days^{-3}	9.53	13.07	15.19	18.19^{ab}	22.35^{ab}
W_3 = 0.2 L baby polybag^{-1} days^{-4}	9.27	12.82	13.09	15.99^{b}	16.15^{b}

Numbers followed by the same letter in the same column and the same treatment are not different significantly with LSD test at the 5% level

Table 2: Effect of Vedagro and water stress treatment to stem diameter of palm oil seedling at ages 4-12 Weeks After Planting (WAP)

	Stem diameter (cm)				
Treatments	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
V_1 = 5 g baby polybag^{-1}	3.25	4.33	4.59	4.92	5.52
V_2 = 10 g baby polybag^{-1}	3.19	4.37	4.56	5.06	5.74
V_3 = 15 g baby polybag^{-1}	3.30	4.41	4.80	5.45	6.06
W_0 = 0.2 L baby polybag^{-1} days^{-1}	3.29	4.48	4.95	5.54	6.20^{a}
W_1 = 0.2 L baby polybag^{-1} days^{-2}	3.26	4.31	4.71	5.17	5.91^{ab}
W_2 = 0.2 L baby polybag^{-1} days^{-3}	3.23	4.44	4.54	5.02	5.56^{a}
W_3 = 0.2 L baby polybag^{-1} days^{-4}	2.20	2.24	2.39	2.40	2.41^{b}

Numbers followed by the same letter in the same column are not different significantly with LSD test at the 5% level

Table 3: Effect of Vedagro and water stress treatment to number of leaves of palm oil seedling at ages 4-12 Weeks After Planting (WAP)

	Number of leaves				
Treatments	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
V_1 = 5 g baby polybag^{-1}	2.64	3.62	4.59^{a}	5.59	6.03
V_2 = 10 g baby polybag^{-1}	2.67	3.67	4.62^{b}	5.70	6.31
V_3 = 15 g baby polybag^{-1}	2.73	3.73	4.73^{c}	5.89	6.39
W_0 = 0.2 L baby polybag^{-1} days^{-1}	2.71	3.71	4.71^{b}	5.89	6.60
W_1 = 0.2 L baby polybag^{-1} days^{-2}	2.71	3.71	4.67^{b}	5.71	6.52
W_2 = 0.2 L baby polybag^{-1} days^{-3}	2.71	3.71	4.71^{b}	5.82	6.11
W_3 = 0.2 L baby polybag^{-1} days^{-4}	2.60	3.56	4.49^{a}	5.49	5.74

Table 4: Leaf area plant due to Vedagro fertilizer dose treatment and water stress treatment at ages 12 Weeks After Planting (WAP)

Treatments	W_0 0.2 L baby polybag^{-1} days^{-1}	W_1 0.2 L baby polybag^{-1} days^{-2}	W_2 0.2 L baby polybag^{-1} days^{-3}	W_3 0.2 L baby polybag^{-1} days^{-4}	Average
V_1 = 5 g baby polybag^{-1}	32.01	31.14	18.17	11.10	23.11
V_2 = 10 g baby polybag^{-1}	32.17	31.46	19.23	11.27	23.53
V_3 = 15 g baby polybag^{-1}	32.97	32.60	23.50	12.30	25.34
Average	32.38^{a}	31.73^{a}	20.30^{b}	11.56^{c}	23.99

Numbers followed by the same letter in the same row are not different significantly with LSD test at the 5% level

The diameter of the plants continues to increase with increasing ages (Table 2). The pattern is the same, the higher the dose of fertilizer the higher the stem diameter was found, on the other hand, the less water the more depressed stem diameter of seedlings. Watering 0.2 L baby polybag^{-1} days^{-4} significantly reduces stem diameter of oil palm seedlings as many 3.79 cm at 12 weeks after planting.

The number of leaves continues to increase with increasing age (Table 3) although the effect of Vedagro fertilizer is not significant. The effect of water stress is also not significant on the number of leaves.

Leaf area due to Vedagro fertilizer dose treatment and water treatment at ages 12 Weeks After Planting (WAP) shown in Table 4. The effect of Vedagro fertilizer and the combination treatment of Vedagro and water stress is not significant. Watering 0.2 L baby polybag^{-1} days^{-4} significantly reduces the leaf area of oil palm seedlings at 12 weeks after planting.

The observational matrix at age 12 WAP with water stress treatment is shown in Table 5. Increasingly lack water, all parameters observed were significantly reduced except for the number of leaves is not significant. Increasingly lack water, ABA content increased in leaf. The regression

Table 5: Observational matrix at age 12 WAP with water stress treatment

Treatments	Plant height (cm)	Stem diameter (cm)	Number of leaves	Leaf area (cm^2)	ABA (ppm)
W_0 = 0.2 L baby polybag^{-1} days^{-1}	23.96^{a}	6.20^{a}	6.60^{ns}	32.38^{a}	2.52^{b}
W_1 = 0.2 L baby polybag^{-1} days^{-2}	23.47^{ab}	5.91^{ab}	6.52^{ns}	31.73^{a}	3.46^{ab}
W_2 = 0.2 L baby polybag^{-1} days^{-3}	22.35^{ab}	5.56^{a}	6.11^{ns}	20.30^{b}	3.53^{ab}
W_3 = 0.2 L baby polybag^{-1} days^{-4}	16.15^{b}	2.41^{b}	5.74^{ns}	11.56^{c}	4.86^{a}

Numbers followed by the same letter in the same column are not different significantly with the LSD test at the 5% level

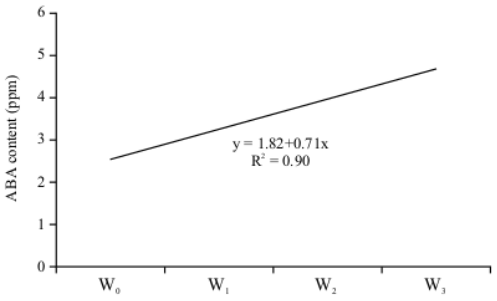

Fig. 1: Relationship between water stress and ABA content at ages 12 WAP

equation of water stress with ABA content is shown in Fig. 1. Figure 1 shows that Increasingly lack water in palm oil seedlings at ages 12 WAP then the ABA content increased, Y = 1.82+0.71 X, r = 0.99. This can be interpreted in the agronomic approach that each decrease of 1 L in watering will increase the ABA content = 0.90 ppm.

DISCUSSION

Fertilizer can add nutrients in the soil, so that plant growth increases with the availability of nutrients. Fertilizers that are put into the soil will be decomposed by microorganisms and nutrients released and become available or can be absorbed by plant roots. Overall, Vedagro fertilizer can increase the growth of oil palm seedlings. This is alleged because it can supply nutrients, improve the physical, chemical and biological properties of the soil, in turn, the soil can provide nutrients in a balanced amount. These results are not much different from those obtained previously on cassava that Vedagro fertilizer increased tuber yield about 79%[8]. Application of Vedagro fertilizer at a dose of 5, 10, 15 and 20 g baby polybag^{-1} significantly affects plant height, leaf area, total dry weight of plants. Vedagro fertilizer containing macronutrients such as N: 11-12%, K_2O: 4.5-6.0%, P_2O_5: 0.4-0.6%, Ca: 1.1%, Mg: 1.9-2.2% and micronutrients consisting of Fe, Mn, Cu, Zn, B and Mo are suitable for increasing growth of oil palm seedlings. Vedagro fertilizers also contain aspartic acid, glutamic acid, Alanine, Valine, Isoleucine, Leucine, Tyrosine, Lysine and Arginine[4].

Each plant has a different sensitivity to water stress, but tillering and grant vegetative growth stage were the target of many studies because they are important growth phases from a crop production perspective[9]. Water stress decreases plant growth and this is very closely related to plant metabolism, ABA is produced in large quantities as a mechanism of adaptation of plants to water scarcity/drought or dehydration[9-11]. ABA leads to feedback inhibition of photosynthesis with the aid of carbohydrate accumulation and decline in the concentration of photosynthetic enzymes which result in the sequencing of photosynthesis arrest, automatically, growth of plants also arrest. Water stress-causing osmotic stresses and cellular dehydration and water-stressed vegetation have more concentration of ABA than the good-watered crops, which restricts growth predominantly inhibit shoot growth[9-12] and supplying 75% water from soil field capacity on oil palm still possible[13], oil palm plant with water scarcity significantly reduces growth and oil yield but elevated ABA and cytokinin content as a typical osmoprotectant to maintain cell stability during cell dehydration which is the common response of a plant to drought stress[14-15].

The implication of this research is to facilitate the selection and application of fertilizer for oil palm seedlings, which means that the higher the Vedagro fertilizer as classified as organic fertilizer, the higher growth of oil palm seedlings is. As a recommendation of this study is effect Vedagro fertilizer would be significant on oil palm seedlings at high doses of 15 g baby polybag^{-1}, while the watering should be according to the suggestion of 0.2 L of baby polybag^{-1} day^{-1} water. The limitation of this study has not been tried in multi-location dry areas in Indonesia and needs to increase response variables.

CONCLUSION

Vedagro Fertilizer up to 15 g baby polybag^{-1} increase significantly plant height, but no significant effect to stem diameter, the number of leaves and leaf area of oil palm seedlings in the pre-nursery. Water stress decreases significantly in plant growth, namely plant height, stem diameter, number of leaves, leaf area of oil palm seedlings but ABA content increase significantly. Water stress can increase the ABA content as many 0.0022 ppm cm^{-2} leaf area. The

interaction of doses of Vedagro fertilizer and water stress has no significant effect on plant height, stem diameter, number of leaves and leaf area of oil palm seedlings in the pre-nursery.

SIGNIFICANCE STATEMENTS

This Study discovers the effect of Vedagro fertilizer to produce better growth of oil palm seedlings and the effect of water stress on seedling growth. This study will help researchers, farmers, seed industry to uncover the critical areas on the nursery in various places in Indonesia. Thus, a new theory is found that on water stress can be predicted ABA content formed, may be arrived at.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7