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Response of Three Varieties of Patchouli (*Pogostemon cablin*, Benth) Due to Drought Stress

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Abstract

The study aims to investigate the way of growth response, the result, and proline accumulation of three varieties kinds of the national best quality of patchouli (*Pogostemon Cablin*, Beth) under the thread of drought stress. The research is done in plastic house in Reuleut Timu village, Muara Batu subdistrict, Aceh Utara Districk, from June – November 2015. The research is held by using split-plot design by six replications of two factors, namely the provision of water factors (K) at field capacity (FC) as the main plot, K_1= provision of water 100% FC, K_2 = provision of water 75% FC, K_3 = provision of water 50% FC, K_4 = provision of water 25% FC. The varieties of patchouli (V) as sub-plot, V_1 = Lhokseumawe (from Lhokseumawe/North Aceh), V_2 = Tapaktuan (from Tapaktuan / South Aceh), V_3 = Sidikalang (from Sidikalang, North Sumatera). The parameter measured were plant height, number of branches, length of the root, weight of wet plant, leaf area, proline accumulation, and the total amount of chlorophyll. The result showed that the water in different field capacity had a significant effect on plant height, root length, wet weight, and total amount of chlorophyll of leaves and highly significant on accumulation of proline content in leaves of patchouli. The bigger drough stress will reduce vegetatif growth and the total amount of chlorophyll and would incerase the accumulatin of proline in leaves.

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The best respond vegetative growth patchouli to drought stress obtained in Tapaktuan varieties shown in plant height, number of branches and root length highest compared to the other varieties. Varieties Tapaktuan also accumulation the highest proline as response to the greater drought stress given.

Keywords: chlorophyll; drought stress; patchouli; proline.

1. Introduction

Patchouli (*Pogostemon cablin,* Benth) is aromatic shrubs that produces essential oil called *atsiri* classified in Lamiaceae family. The Plant is from subtropical region of Himalaya, Southeast Asia and East Asia that is cultivated Indonesia, Malaysia, China, and Brazil. The central production of patchouli in Indonesia is located in Aceh, North Sumatera, West Sumatera, South Sumatera, Bengkulu, Lampung, West Java, Central Java, and East Java, South Kalimantan, Central Kalimantan, Central Sulawesi, South Sulawesi, West Sulawesi, and Southeast Sulawesi [1].

Patchouli plant has shallow root so that it is less resistant toward drought stres. The character of rooting morphology of patchouli has caused the high sensitifity toward the deficiency of soil moisture that will affect the plant growth [2].

Generally, patchouli is cultivated in dry field by relying heavily the resource of water from precipitation without adding fertilizer based on plant needs. Patchouli needs the volume of water or precipitation from 2.500 – 3.000 mm per year to be able to grow and produce well. In average, the annual precipitation in North Aceh is about 1.478 mm. With that amouth of the rainfall, it is assumed that will be insufficient amouth to cultivate patchouli plant with water shortage that can be leaded to drought stress situation.

Drought stress is not expected in the cultivating of plant because it can inhibit the growth and crop production. Plants experiencing drought stress will provide adaptive responses in order to survive, so it has a drought stress tolerance. Tolerance of plants to drought stress involves the accumulation compound to protect plant cell from damage that may happen during the water shortage period. Proline plays significant role to avoidance the dehydration by increasing solute cell level as well as maintaining the volume of water remains high. The accumulation of proline has role to determine the drought tolerance by protecting protein and membrane structure [3]. The use of verieties of patchouli with a good response to drought stree is one of the most efficient technologies and cheap. In Indonesia has released several excelent varieties of pathchouli, three of which are varieties Lhokseumawe, Tapaktuan and Sidikalang which has a high yield production [4]. All three are stil relatively vulnerable to drought stress is high, thereby potentially degrade production results. This research aims to study how the growth response, result and accumulation of proline three varieties excelent in various conditions of drought stress.

2. Method

2.1. Place and time

The research was conducted in the village of Reuleut Timu, Muara Batu Subdistrict, North Aceh District in

altitude ± 8 m above sea level (asl) in the plastic house from July, 2015 - Desember 2015. The material used in experiment is seed varieties of patchouli kind *Pogostemon cablin*, Benth, varieties of Lhokseumawe, Tapaktuan, and Sidikalang, Menure, polybag, urea fertilizer, SP-36 and KCl, MgO, Sevin 85 SP and Dithane M 45.The tool used, digital scale, leaf area meter, sprayer, scissors, plastic string, ruler, computer, stationary and so on. Using split-plot design in the basic design of a randomize with six replictions consisting of two factors, ie, foctor of provision of water (K) at field capacity (FC) as the main plot, K_1 = provision of water 100% FC, K_2 = provision of water 75% FC, K_3 = provision of water 50% FC, K_4 = provision of water 25% FC. Factors varieties of patchouli (V) as subplots, V_1 = Lhokseumawe (Lhokseumawe origin/North Aceh), V_2 = Tapaktuan (origin Tapaktuan /South Aceh), V_3 = Sidikalang (origin Sidikalang North Sumatera).

There are 72 experimental plots and each plot there are 7 polybag planted 1 seed patchouli. The data were analyzed with ANOVA and if there are real is significant continued with further test of LSD level of 5%.

2.2. The Implementation of Research

Plant material are from cutting shoot with diameter from 0,8 – 1,0 taken from young wooden branch. The cutting shoot is cut in size of 20 cm. The shoot is planted in polybag of volume kg^{-1} that is contained the mixture soil and manure. The seed that has had shoot and leaves is moved out to polybag in size 60 kg of soil. The treatment of drought stress is tested on one month old after planting based on appropriate treatment. Polybag is arranged in distance of plant 60 cm x 40 cm on the experimental plot randomized. The maintenance includes watering, weeding weed, and pest eradication. The fertilization of patchouli is done in two weeks before planting in accordance with the recommende dosage.

The water volume on field capacity is measured everyday by using tensiometer (*soil moisture tester*) in order to determine the time and the amount of water that has to be provided for every experimental plot. To find out the respons of patchouli toward the drought stress, the observation is conducted on the age 180 days after planting (dap) on the plant height, the number of branches, the length of root, the weight of wet plant, the leaf area, the proline accumulation *(analysed based on methodology of* Bates *et al*. 1973), and the sum amount of chlorophyll (using *Opti-sciences; CCM 200 plus portable*).

3. Result and Discussion

3.1. Result

The research outcome shows that the treatment of watering on field capacity causes significant on the plant height, the number of branches, the length of the root, the weight of wet plant, and the total amount of chlorophyll. It also contributes the highly significant on the sustention of proline accumulation on patchouli. The treatment varieties showed significant on leaf area, highly significant on plant height and accumulation of proline content of patchouli.

Drought stress generally impedes the growth and the yield of patchouli. It is indicated by height of plant , number of branches, length of the root, weight of wet plant, and the leaf area that keep deterioting as the result of the amount of water is decreased toward field capacity (the less water provided, the worse drought stress) will

be provided. The fast progress of growth generally is showed by K_1. The more and more sluggish progress of growth is shown by K_2, K_3 dan K_4. The growth development decrease (K_2, K_3 and K_4) in average compared with K_1 based on the height of plant which is about -7,83 cm, length of root about -3,36 cm, and the weight of wet plan -49,05 gram. The variety of Lhokseumawe can respond very well on any volume of provided water on field capacity for its growth for the length of root parameter, variety Tapaktuan can respond very well for its height parameter and the number of branches, while variety Sidikalang has good respons toward the weight of wet plant and the leaf area.

The treatment of water supply on field capacity indicates the highly significant on proline accumulation toward leaves of patchouli. The high accumulation of proline is achieved by providing the water on field capacity 50% (K_3) and then it is followed by K_2, K_1 dan K_4. Accumulation of proline greater with greater drought that occurred. Variety Tapaktuan has the highest proline accumulation, and then is followed by varieties of Lhokseumawe and Sidikalang.

Table 1: Plant Height in average (PH), the number of branches (NB), Root Length (RL), the weight of wet plant (WWP), leaf area (LA), Proline (Pro), and total amount of chlorophyll (Chl) the plant of patchouli on the age of 180 days after planting as the outcomes of provided water on field capacity (FC) and varieties.

Treatment/ Parameter	PH (*cm*)	NB (*unit*)	RL (*cm*)	WWP (*gram*)	LA (cm^2)	Pro (#)	Chl (*CCI*)
Water field capacity							
K_1	52,48 a	7,13 a	33,55 a	173,55 a	31,33 a	52,37 c	29,05 a
K_2	50,48 a	7,70 a	33,51 a	143,38 ab	37,50 a	61,43 b	26,51 a
K_3	42,33 b	6,96 a	29,54 ab	122,54 b	29,93 a	63,68 a	15,78 b
K_4	41,14 b	6,90 a	27,51 b	107,58 b	33,50 a	49,95 d	15,19 b
LSD 0,05	*	ns	*	*	ns	**	*
Varieties							
V_1	42,53 b	6,70 a	32,44 a	125,57 a	30,49 b	58,22 b	22,63 a
V_2	53,75 a	7,95 a	28,96 a	140,41 a	30,43 b	62,49 a	20,39 a
V_3	43,55 b	6,86 a	31,68 a	144,31 a	38,35 a	49,86 c	21,88 a
LSD 0,05	**	ns	ns	ns	*	**	ns

Description : the number followed by the same letters on the same column are not significantly according to LSD test the 0,05 level (ns = non significant, * =significant, ** = highly sicnificant)

CCI = % transmittance at 931 nm. **(#) =** µmol/gram fresh weight of leaf

The supplied water on field capacity gives differences of total amount of chlorophyll on patchouli leaves. The largest amount of chlorophyll is found on high supplied water of field capacity of level K_1 and is gradually followed by K_2, K_3 dan K_4. This shows that the less supply of water (the bigger drought stress will be faced), the

lower total amount of chlorophyll will become. Variety Lhokseumawe has the highest total amount of chlorophyll followed, Sidikalang and Tapaktuan, but all these varieties do not indicate the significant on total amount of chlorophyll

3.2. Discussion

The magnitude of plant height in the K_1 and K_2 thought to be caused by nutrient uptake by the roots due to the availability of sufficient water in the soil, resulting in the increase of plant height. The plant will absorb soil nutrient easily if there is adequate amount of water in soil. It is corresponding to [5] that the absorbtion of soil nutrient by plant is influenced by the availability of soil nutrient and water in soil. [6] also point out that the maximum absorbtion of soil nutrient by plant is determined by the height of regime of supplied water because water has significant role for plant in absorbing soil nutrient. The water as agent is able to dissolve soil nutrient and transports it to plant tissuebecause of water mobility factor [7].

On the other hand, the less height of plant and lower level of water on field capacity is caused by the decreasion of absorbtion of soil nutrient as the result of depletion of soil humidity. It happens due to the deterioritation of soil nutrient diffusion level from matrix soil to the surface of absortive root [8]. In general, drought stress decreases the absorption of soil nutrient by root and the limited amout of nutrient to young shoots can happen [9].

Reference [10] mention that the growth and the development of plant is highly influenced by water in plant tissue. If the amount of water in plant tissue is sufficient, all process that influence the growth and the development of plant will run well. However, if the amount of water in plant tissue is insufficient, all the process of growth and development of plant will be hampered.

The plant that suffers from water shortage generally has smaller size than the one plant to grow normally. The water shortage can decrease the productivity of plant significantly and even lead to the death of plant [11]. Reference [12] also state that under drought stress, plant will decrease the size of its branch. Water shortage contributes negative effect on number of plant leaves and total leaf area particularly during severe water shortage [13].

The availability of water on field capacity is very sufficient for roots to absorb soil nutrient and other substances that is needed by plant for its metabolism thus the plant is higher than the one that suffers from drought stress [14]. The study conducted by [15] revealed that the drought stress can decrease the height of plant and the number of peanut branches, the varieties of kelinci and singa. The reduction of plant growth is from -13% to-31%.

There are huge actual differences on the length of plant root of patchouli that is influenced by the availability of water around root plant. Based on observation, it revealed the high volume of water on K_1 that contributes the longer root then the others. Low amount of ground water on layer of top soil will impede the elongation of root that leads to reduction of soil nutrient absorption by plant.

On parameter of root length, variety Lhokseumawe has longer root than other varieties. The plant that is more tolerance toward drought stress has better development on root than the one that is more resistant on drought stress. Patchouli plant is able to search water by elongating its root in deeper ground of polybag in more humid condition [16]. It is also mentioned by other scholars [[17,18]] that the growth of root system will be more effective than perforation growth when the plant is on drought stress condition. However the different condition actually is found on *Catharanthus roseus* [19] and *Abelmoschus esculentum* [20].

The result of drought stress on patchouli plant cause the hindrance of root development, plant height, the number of branches, the leaf area that later on will decrease plant productivity (biomass/weight of wet plant) as the result of the deteriotation of primary metabolism, the depreciation leaf area and disruption of photosynthesis [21, 22].

Sidikalang varieties have greater weight than other varieties, but did not show significant. However, the different outcomes is shown based on the research done by [16] that the varietyof Tapaktuan of its wet plants has higher weight that indicates better resistant of the plant while facing drought stress. Drought stress decrease the yield component of plant. Plants are given water sufficient to provide high agricultural yields [23].

The provision of water at field capacity that the lower the amount causes a decrease in groundwater levels and increase levels of proline accumulation in leaves of patchouli. The increasing of proline level is due to the increasing of drought stress that happens on the plant [24, 25].

The high level of proline accumulation of K_3 is as part of plant attempts to reduce oxidative need in order to be able to survive during drought stress as mentioned by [26] on plant *Frankenia leavis* the plant is able to survive on drought condition and accumulate proline on the leaves.

The research finds out that varieties Tapaktuan can accumulate higher level of proline, followed by varieties of Lhokseumawe, Sidikalang varieties. This is the same obtained from research on [16] who received the highest proline accumulation on the variety Tapaktuan, however different obtained in the result by [27,28] that gets the highest accumulation of varieties Sidikalang have followed varieties Lhokseumawe and varieties Tapaktuan..

The decreasion amount of water ground (the higher drought stress) will decrease the total amount of chlorophyll on patchouli leaves. The total amount of chlorophyll will be reduced because of the reduction amount of water ground. The same thing happens on treatment of drought stress on others plants, which during its growth decline in total amount of chlorophyll bean plants [29], sun flower [30]. The reduction of chlorophyll is caused by differences of physiological and biochemical respons of the plants. The research conducted on *Frankenia leavis* plant by [26] reveals that the highest total amount of chlorophyll is found on control treatment experiment (100% field capacity) which has different result from field capacity on level 70% and 50%.

4. Conclusion

By providing water on different field capacity, it contributes different effect on vegetative growth, weight of wet, the accumulation of proline contents, and the total amount of chlorophyll on patchouli plant. The greater

the drought stress is given will be decrease the vegetatif growth of patchouli, the total amount of chlorophyll and increase the accuulation of prolin in the leaves of patchouli.

The best vegetative respons on patchouli plant toward drought stress is found out on variety of Tapaktuan which shows the highest progress of plant growth of the others including height of plant, the number of branches, and the length of root. Variety of Tapaktuan also has highest proline accumulation in responding the worse drought stress given to the plant.

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