The Level of Water Supply and its Effect on the Growth of Plants and Yields Patchouli (*Pogostemon Cablin*, Benth.)

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Abstract. Patchouli is a plant of essential oils cultivated dry land without any irrigation except rainfall only. The low amount of water in cultivation is a common constraint and hampers growth and patchouli yield. This study aims to obtain the appropriate level of water content on patchouli cultivation in rain-fed and how it impacts on growth and results. Implemented in Reuleut Timu Village Muara Batu District, North Aceh District from June to December 2015. Using randomized block design a repeated of 9 (nine) times with the following treatments: K_1 = water supply 100% of field capacity, K_2 = water supply 75% field capacity, K_3 = water supply 50% field capacity K_4 = water supply 25% field capacity. The results of this study indicate that the water content in the field capacity showed very significant difference to the patchouli leaf area. 75-100% moisture content results in better oil production and growth, while the highest patchouli alcohol content is achieved at 50% moisture content. The lower the water content given, the more negatively affect the growth and yield of patchouli plants.

Keywords: Patchouli Alcohol, Moisture Content, Water Shortage, Field Capacity.

1 Introduction

Patchouli (*Pogostemon cablin*, Benth) is an essential oil producing plant originating from the subtropical of the Himalayas, Southeast Asia and the Far East and is widely cultivated in Indonesia, China, Malaysia, and Brazil [1]. Aceh is the best quality patchouli oil producer and has become Indonesia's largest supplier of patchouli oil in the international market [2, 3].

Grows well in height up to 1,200 m above sea level. Patchouli cultivation is very suitable to be done in areas with sufficient rainfall, especially in the highlands. Patchouli cultivation in the lowlands is often lack of water and irrigation is needed to fulfill it. Plants with water shortages generally produce low growth and production and can have an impact on cultivar failure. The need for water or rainfall of patchouli plants to grow and produce well ranges from 2,500 - 3,000 mm per year [1]. Compared to the average annual rainfall in North Aceh of 1,478 mm/year, there will be a shortage or inadequate water demand so that patchouli plants

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are potentially in a state of water shortage. Generally patchouli cultivated on land with irrigation from rainfall only. Patchouli plants have shallow rooting so less resistant to drought.

Such rooting morphological characteristics cause patchouli very easily to experience water shortages resulting in disruption of growth and production. Such root morphological characteristics and low rainfall and uneven fall in each month to make the patchouli cultivation of the place into the category does not fit.

In general, the average yield of leaves (terna dry) on patchouli plants is about 15 tons / ha or about 290-375 kg/ha of patchouli oil with 32-33% patchouli alcohol content.

To date, information on how moisture still in the patchouli plant tolerance to grow and produce well unknown. To know the level of moisture which is good for growth and results achieved, and then conducted research with the treatment the granting of different moisture on plant patchouli. This study aims to obtain the appropriate level of water content on patchouli cultivation in rain-fed and how it impacts on growth and results.

2 Materials and Methods

Research was conducted in Reuleut Timu village, sub-district of Muara Batu in North Aceh Regency height ± 8 m above sea level (asl). Implemented from June to December 2015. The material used is patchouli Pogostemon cablin Benth, cow manure, polybag, urea fertilizer, SP-36 and KCl, 3 G, fungicide and insecticide.

Tools used include oven, digital scales, leaf area meter. Implemented in a plastic housing using a non factorial randomized block design. The treatment given is the level of water delivery, which consists of 4 levels ie : K_1 = water supply 100% field capacity, K_2 = water supply 75% field capacity, K_3 = water supply 50% and K_4 = water supply 25% field capacity, repeated 9 times.

Cuttings for seedlings taken from branches that are young but have wood with a length of 15-20 cm. The topsoil mixed with manure as a seedbed medium is inserted into the polybag and arranged at a distance of 20 cm x 20 cm.

Each polybag planted with a patchouli seedlings and given a shade of paranet. Cuttings seedlings maintained until one month or have had shoots and then moved into large polybag (60 kg). The planting medium at 60 kilograms of size polybag is the soil top soil that was already crushed. The soil top soil mixed with cow manure with a comparison of 2:1.

The patchouli seedlings were planted into polybags of 60 kg and arranged with 60 cm x 40 cm plant spacing in each randomized trial plot. Planting is done by making the planting hole according to the size of polybag seedlings, then put the seeds along with the media seedlings. Each large polybag planted with one seed of patchouli plant.

To ensure perfect growth occurs watering, fertilizing, weeding and plant pests eradication. If there are plants that die or grow imperfectly done embroidery.

Provision of water treatment is done after the plant are thirty days after transplanting (dat) according to the percentage of field capacity, and carried up to the age of patchouli six months. To ensure the level of groundwater content, each treatment unit measured its water content with a tensiometer.

Weeding is done by unplugging the plant pest (weed) on each poly bag to suit your needs. For tackling pest plant disease is done by spraying with insecticides and fungicides. Spraying plant disease pests are done according to your needs.

Observation on the growth and yield were performed on plant height, leaf number, leaf area, root length, oil production, patchouli alcohol (PA) content at 180 days after planting. The

data were analyzed by anova and futher test the least significant difference (LSD) on levels 5%.

3 Results and Discussion

The result of variance analysis showed significant difference to leaf area due to treatment of water content. The highest leaf area was achieved at the K_1 treatment stage with 100% moisture content of 33.99 cm^2, followed by K_2 25.99 cm^2, K_3 22.47 cm^2 and K_4 21.70 cm^2.

The giving of water treatment does not show a significant difference against the high number of plants, leaves and the root length. Although not a significant difference, the greatest plant height indicated by the extent of awarding 100% of water levels (K_1) of 45.07 cm followed by K_2 of 44.85 cm, K_4 of 39.80 cm, and K_3 of 38.80 cm. The same thing happened against the parameters of the length of the root, where the root is the longest in the show by K_1 of 26.91 cm followed by K_4 of 26.19 cm, K_2 and K_3 amounting to 25.89 cm by 22.00 cm, while the number of leaves in the show's highest level of treatment by K_2 of 51.13 strands followed by K_1 of 50.80 strands, K_4 of 45.00 K_3 of the strands and strands of 40.79 (Figure 1).

Treatment of water content is lower the negative effect on the growth of patchouli plants is the decrease in plant height, leaf area, the number of leaves, and the length of the roots of patchouli plants. Water content of K_1 treatment level on the parameters of plant height was better by 0.48% of K_2, 13.91% of K_3 and 11.70% of K_4. On the parameters of the large decrease of leaf number seen at K_3 and K_4 that is equal to 20.30% and 11.99% compared with K_1, while at K_2 level able to increase the number of patchouli leaves by 0.65%. Patchouli plant root length parameter which is the organ of water absorption and nutrients produces the highest root length on treatment water content level K_1 and larger 3.79% from K_2, 18.24% from K_3 and 2.67% from K_4. Against the broad parameters of leaves, granting the lower water levels cause a decrease in the broad leaves are getting bigger. When compared to K_1 treatment stage, the decrease of leaf area occurred at K_2 is 23.55%, at K_3 level of 33.88% and 36.18% in the K_4 level (Figure 1). The greater the water given the greater the effect on the increase of plant height growth, the number of leaves, the leaf area and the lenght of the patchouli plant roots, otherwise the smaller the water content given decrease the growth of patchouli plant.

The 100% water supply levels result in higher patchouli oil than other moisture content. This indicates that patchouli plants require a sufficient amount of water and are always available, but not excessive. At low water availability levels, the energy allocated for growth will decrease as a result of the amount of energy required to absorb water so that the respiration rate is greater than photosynthesis. Research results Wiroatmodjo, et al. [4]; Kadir [3] indicates that low water levels decrease the number of branches and the number of patchouli leaves Effects Water deficiency in plants causes a decrease in plant height and leaf area [5], significantly reduced fresh and dried biomass yields with increasing water shortages [6]. The research of Amiri, et al. [7], water stress significantly affects plant growth decline, for example at plant height. Severe water shortages are more damaging than moderate water shortages [8]. Low moisture depresses significantly the expansion of cells and growth due to low turgor pressure.

Setting the osmotic turgor maintenance can allow cells to survive or to aid plant growth under severe drought conditions [9]. Water shortages inhibit shoot growth as indicated by decreased growth in plant height, number of root and number of leaves [10].

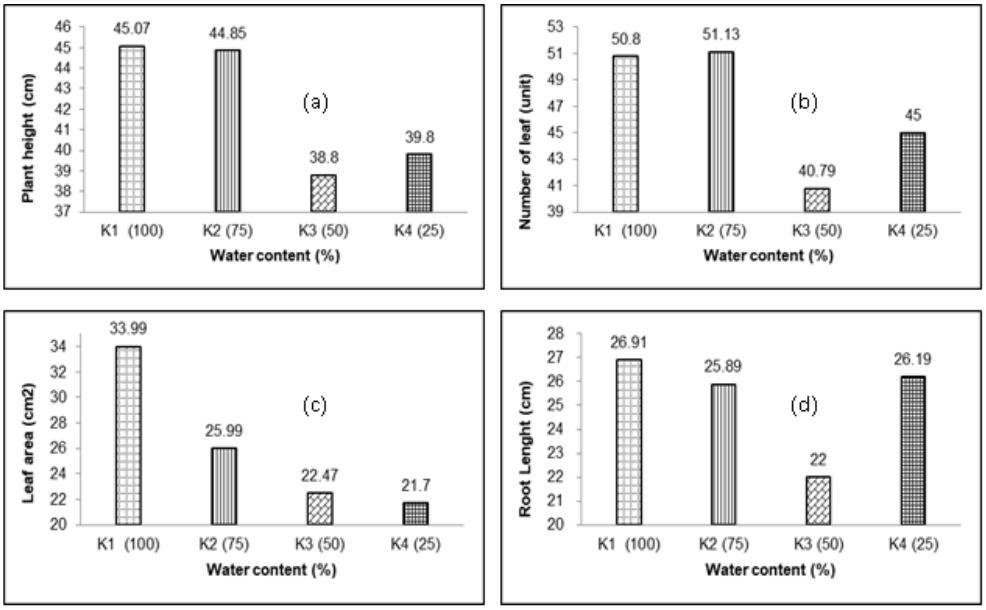

Figure 1. Patchouli growth on plant height parameters (a), number of leaves (b), leaf area (c) and root length (d) of patchouli plant.

In this research, plant patchouli has small leaves, the habitus is rather small and thick, reddish yellow green color somewhat because it is grown in the open. Patchouli plants grown in the open, less growth, smaller plants running, rather small and thick leaves, the leaves are yellowish and slightly red, it is because of the disruption of cell division which lowers growth and results, but higher oil levels [11, 12]. Low water content affects all plant growth variables observed. Plants given adequate water (75-100%) have a growing number of leaves, root biomass, plant height, and leaf area larger than the water supply of 25-50%. The low input of water causes low biomass growth of leaves and leaf area. Low water input causes low leaf biomass growth and leaf area. The formation of leaves, roots and stems is significantly influenced by the water content given [13]. Whilst Manivannan, et al. [14] revealed that the decrease in plant height associated with a decrease in cell enlargement and leaf aging, under water deprivation conditions. Increased water supply results in increased plant height and number of leaves, and low water delivery drastically decreases the number of leaves and leaf area [15, 16].

The low amount of patchouli leaves in the treatment of more severe water shortages caused by the existence of plants has waived its leaves to reduce excessive evaporation. In addition, research conditions under plastic house higher temperatures followed by the low humidity makes faster portion dismissed the patchouli leaves, especially old leaves. The plant is more sensitive to water shortage more abort the leaves [17]. Plant growth can be inhibited by low water potential, this can be shown in the growth of leaves and stems [18]

Height of plants under heavy water shortage is lower than in moderate water shortages, this may be due to more concentrated plants prolonging the roots to obtain more water from deeper sources, less root inhibition than upper canopy growth [19, 20]. Some roots continue to lengthen to a low groundwater potential and reduce shoot growth (Kirnak, et al. [18]. A productive root system can provide benefits for spurring plant growth at an early stage of its

growth and facilitating the rapid absorption of water lost by evaporation [21].). Increased root growth due to water stress occurs in sunflower as reported by Tahir, et al. [22] and plant Catharanthus roseus [23].

This study shows that patchouli plants can still continue the process of growth and development to water shortages at levels up to 25 percent, but in research Setiawan, et al. [24] the plant can still continue its life up to 20 percent groundwater content.

Treatment of water content resulted in the highest production of Patchouli oil at K_1 (100%) level of 4.91 gram followed by K_3 (50%) 4.90 gram, K_2 4.23 gram and K_4 2.64 gram (Figure 2a). In general, the greater the provision of water in patchouli plants produce oil is higherl, except in K_3 able to produce oil weight is almost equal to K_1. The treatment of the amount of water in decreased field capacity resulted in decreasing production of patchouli oil. Compared to K_1 treatment level, water supply in K_2 field capacity causes a decrease of patchouli oil production by 13.85%, K_3 decreases yield of 0.20% and K_4 decreases yield by 46.23%.

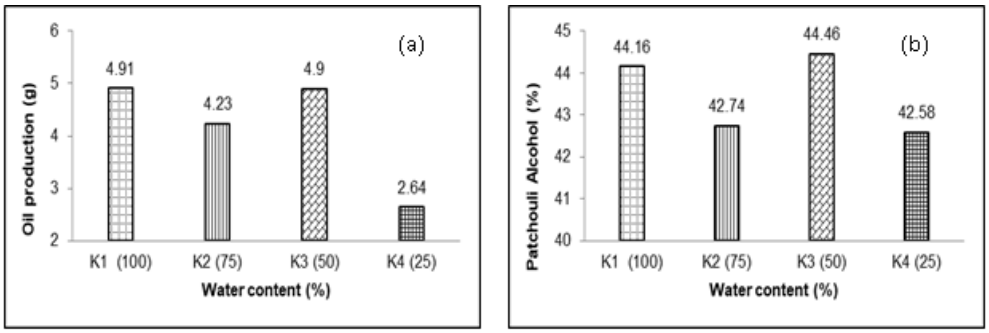

Figure 2. A comparison of patchouli oil production (a) and patchouli alcohol content (b) patchouli plants due to the treatment of moisture content.

Treatment of water content resulted in differences in patchouli alcohol content of patchouli oil (Figure 2b). The highest patchouli alcohol content was demonstrated at water content in 50% (K_3) field capacity with patchouli alcohol content of 44.46% followed by K_1 44.16% (0.67% lower than K_3), K_2 42.74% (3.87% lower than K_3) and K_4 42.58% (4.23% lower than K_3) (Figure 2).

The decline in crop production results related to a decrease in the number of leaves and interference in the process of cell division [25]. Water stress reduces fresh weight and dry weight of plants, but the more severe the water shortage will increase the essential oil content than light water stress [26]. Differently expressed in plants Matricaria chamomila the greater the water shortage that is given further lower the high content of essential oils and plants. A decrease in the content of essential oil may be caused by the presence of interference in photosynthesis, carbohydrate and production at the time of formation of water shortage, the formation of secondary metabolism due to depressed plant growth [8]. Lack of water pressed essential oil production instead of sufficiency of water gives higher oil production [27].

4 Conclusion

Giving different moisture content of patchouli plants has a very significant effect on leaf area. Although there was no significant difference in plant height, leaf number and root length, water content with 100% and 75% field capacity resulted in better growth and production compared to water content of 25% and 50% of field capacity. 100% and 50% moisture content resulted in the highest production of patchouli oil, while the highest patchouli alcohol content was achieved at 50%.

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