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The Effect of Groundwater Content on The Growth of Patchouli (*Pogostemon cablin*) in Batu Putih Village, Batu Putih District, Kolaka Utara Regency

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Abstract

Patchouli plants (*Pogostemon cablin*) in Batu Putih Village often die from erratic seasons. Excess soil water content during the rainy season causes plants to rot and die. In other cases, the death of patchouli is also caused by a lack of water content in the soil. This study aims to determine the effect of soil water content on the growth of patchouli (*Pogostemon cablin*) in Batu Putih Village, Batu Putih District, and North Kolaka Regency. This study used a randomized block design (RBD) method with two treatment factors, namely the material type and the groundwater concentration. Each type of material consisted of patchouli, soil and water, while the groundwater concentration consisted of watering 100% (500 ml), 60% (300 ml) and 40% (200 ml). The results showed that watering with 100% groundwater concentration (500 ml) gave the best growth compared to water at 60% and 40% groundwater concentrations. However, the results of the Anova test showed that watering with 100%, 60%, and 40% groundwater concentrations did not have a significant effect on plant growth, it was suspected that water was not the dominant factor in the patchouli plant growth process.

Keywords: Patchouli, growth, soil moisture content, *Pogostemon cablin.*

A. Introduction

Indonesia is a significant producer of patchouli oil-controlling about 95 per cent of the world market. Currently, around 85 per cent of Indonesia's important oil exports are dominated by patchouli oil and are exported to several countries, including Singapore, the

United States, Spain, France, Switzerland, England, and other countries (Directorate General of Plantations, 2020).

Patchouli (*Pogostemon cablin*) is one of the essential oil-producing plants known as patchouli oil (*Patchouli oil*). Patchouli oil is an export commodity that is used as raw material for perfumes, cosmetics, medicines, and the needs of the food industry. Patchouli oil is a fixative that can bind fragrances and prevent the evaporation of fragrance substances so that the fragrance can last a long time. Currently, neither natural nor synthetic can replace patchouli oil (Manurung, 2010).

Based on data from the North Kolaka Regional Government, in 2016, the patchouli plantation area in North Kolaka was around 248 hectares, the inter-island trade volume for patchouli reached 4,274 tons, and patchouli oil reached 150,094 tons. However, patchouli agribusiness in the North Kolaka area began to decline due to erratic weather. The erratic rainy season and summer resulted in patchouli plants experiencing non-optimal growth, so patchouli oil production decreased (Abraham et al., 2019).

Batu Putih Village is one of the villages in North Kolaka Regency, Southeast Sulawesi, where most people grow patchouli as their livelihood. Based on data from the Central Statistics Agency (BPS) of North Kolaka, by 2020, Batu Putih village will be able to produce 150,094,000 tons of patchouli every year. Based on this amount of production, Batu Putih village is ranked 5th as the largest patchouli oil producer in North Kolaka Regency (BPS Kolaka Utara, 2020). In Batu Putih Village, the rainy season almost occurs throughout the year, where from March to June, there is fairly high rainfall, as well as from October to December. The wind currents that occur during these months contain a lot of water vapour that blows from Asia and the Pacific Ocean, so there is a high rainy season. The dry season occurs between January to February and July to September; between these months, the East wind blowing from Australia is dry and contains less water vapour (BPS Kolaka Utara, 2015).

Patchouli cultivated in Batu Putih Village often experience death (harvest failure) due to uncertain reasons. Excess soil water content during the rainy season causes patchouli plants to rot, which causes the plants to die. However, in other cases, the death of patchouli can also be caused by a lack of water content in the soil (Emmyzar, 2014). Based on this description, a study was carried out under The Effect of Groundwater Content on the Growth of Patchouli (*Pogostemon cablin*) in Batu Putih Village, Batu Putih District North Kolaka Regency.

B. Literature Review

1. Patchouli Plant Morphology

Based on the nature of the growth, patchouli plants, including annual plants (Perennial). Patchouli plants are tropical shrubs that grow upright, have many branches, and are stratified. Patchouli plants can reach a height of between 0.5 and 1.0 m. The leaves of the patchouli plant are ovoid to oblong (oval). Patchouli leaves are between 5-11 cm long, 89% green, thin, not stiff, and hairy on the upper surface. The leaves face each other, the leaf surface is rough with jagged edges, the leaf tip is blunt, and the leaf veins protrude. Patchouli plants rarely flower; flowers grow at the end of the stalk, clustered, and have a characteristic reddish-purple colour. The flower stalks are 2-8 cm long and 1-1.5 cm in diameter. The flower crown is 8 mm (Rukmana, 2014). Patchouli has fibrous roots; the trunk is woody, 10-20 mm in diameter, and square in shape. The surface of the stem is rough, green when young, and brownish-green when it is old (Sahwalita, 2016).

Patchouli is very sensitive to drought, so a long drought after harvest can cause death. Patchouli can grow on several types of soil, including andosol, latosol, regosol, podsolic, and cambisol soil, and has a loose soil structure and contains lots of humus (Sahwalita, 2016).

Patchouli plants very much need soil that is fertile and loose, and rich in humus. In this fertile soil, patchouli can give very good results. Patchouli plants will be susceptible to root rot disease caused by fungi on waterlogged soil or water surface that is too shallow. The physical condition of the soil is too heavy (clay), and sandy and calcareous soil are not suitable for patchouli plant growth (Sudaryani, 2020).

Patchouli plants belong to the Labiatae family, which has about 200 genera. Based on its taxonomy, patchouli plants are classified as follows:

Kingdom	: Plantae
Division	: Sprematophyta
Subdivision	: Angiosperms
Order	: Labiatales
Family	: Labiatae
Genus	: *Pogostemon*
Species	: *Pogostemon cablin* (Kurniawan, 2016).

2. Patchouli Plant Physiology

Patchouli is generally cultivated in monoculture on open land and is usually cultivated as an intercropping plant. The limiting factor for patchouli plant growth in the intercropping technique is light. Light is an essential environmental factor and can affect plant reproductive growth. Light intensity also directly affects photosynthesis which is correlated with the yield of organic matter and biomass (Devkota & Jha, 2010).

Patchouli needs protection to support optimal growth, but it does not grow in a very protected place. Patchouli plants require much sunlight, ranging from 75% to 100%. Patchouli can grow well in closed areas, but the oil content is lower than in areas with optimal light intensity (Haryanti, 2010). Singh & Guleria (2012) reported that applying 70% shading resulted in oil content of 2.18% with a PA (Patchouli alcohol) content of 40.95%. Rosman et al. (2016) reported that patchouli planted intercropping between nutmeg trees with 80% light intensity gave an oil content of 1.72% with a PA content of 36.21%.

The patchouli that grows in low light has smaller roots; the number of leaves is limited and is composed of thin-walled cells, which impacts the decreased rate of photosynthesis. The rate of photosynthesis decreases due to the rapid photooxidation of chlorophyll, thereby destroying chlorophyll. Light intensity that is too low will limit photosynthesis and cause food reserves to tend to be used more than stored (Haryanti, 2010).

3. Effect of Water Content on Plants

Water is a substance or material that is essential for life. The benefit of water for plants is as a medium for transporting food from the roots to all parts of the plant. Water is also helpful for the process of photosynthesis. Plant growth usually takes place effectively at night because the water content in plants is higher than during the day (Marjenah, 2010).

Water is also very important in plant physiological processes and is the main thing that is considered in agricultural cultivation. Lack of water will cause plants to become stunted and their development to be abnormal. A lack of continuous water during the growth period will cause the plant to wither and die. Water availability in the cells will activate a number of early germination hormones, such as gibberellins and auxin hormones. In addition, entering water into the seeds helps activate enzymes in the imbibition process (Marjenah, 2010).

C. Methodology

1. Research design

This research was conducted in November-December 2021 in Batu Putih village, Batu Putih District, North Kolaka Regency. Analysis of soil water content was carried out at the Laboratory of the Ninebelas November University, Kolaka. This research was carried out for six weeks from the beginning of planting. Data collection began in the second week after planting. Data were collected three times, once every two weeks. Data collection was done by giving treatment at the beginning of planting by measuring the volume of water. The unit of measurement used in the provision of water is milli litre (ml) starting from the first data collection. Then the measurement data was entered in the table. The experimental design in this study used a Randomized Block Design (RBD). The use of this design is best suited for experiments. This study used four treatments, namely: P0: (watering without measure), P1: (watering 100% of the soil water content of 500 ml), P2: (watering 60% of the soil water content of 300 ml), and P3: (watering 60% of the soil water content of 200 ml) in 3 test.

2. Instrument

The tools used in this study include polybags, measuring cups, tape measure, oven, scales, books, pens, markers, and plastic bags. The materials used include patchouli plants, water, and soil. The first data collection was carried out through direct experiments with the following stages:

1) Tilling land
   The soil used in this research is Regosol soil. After taking the soil, the soil is dried first and then measured to be put into polybags, and then the soil is flushed with water.
2) Preparation of Planting Media
   The planting media used in the form of polybags provided as many as 12 pieces for the treatment design and its repetition. The soil was put into each polybag that had been provided as much as 2 kg; then the polybags were numbered as treatment and repetition of the study. Data were collected two weeks after planting.
3) Plant rhythm
   Watering the plants is done once every three days in the afternoon.
4) Observing
   Observations on the parameters measured were carried out every two weeks after planting, namely at weeks 2, 4, and 6. The parameters to be measured during observations were: plant height, stem diameter, number of leaves and leaf area.
5) Documentation
   Documentation is used to meet the data or information needed for the benefit of the research variables that have been previously designed. This documentation is taken from planting to observation.

3. Technique of Analysis Data

In this study, a one-way ANOVA data analysis technique was used. This technique examines differences between two or more treatment groups, where only one factor is considered or affects the experimental treatment. Suppose the ANOVA test analysis results inform that there is a significant difference between the calculated F and the F table (F count > F table). In that case, a further test will be carried out using the LSD test.

D. Result and Discussion

1. Results

The results of the calculation of the soil water content (KAT) in patchouli (*Pogostemon cablin*) in Batu Putih Village, Batu Putih District, North Kolaka Regency, with the provision of water content are as follows Table 1.

Table 1. The results of calculating the KAT of patchouli (*Pogostemon cablin*) for six weeks of observation.

No	Parameter	Test	Treatment of groundwater content			
			P0	**P1**	**P2**	**P3**
1	Soil water content (%)	1	23.03	20.78	24.86	26.74
		2	21.55	24.39	25.52	25.82
		3	24.38	23.77	25.52	25,72
Average			22.99	22.98	25.3	26.09

Note: P0 = watering without measure, P1 = watering 500 ml, P2 = watering 300 ml, P3 = watering 200 ml.

Based on the study's results in table 1, giving water with a concentration of 100% (500 ml) shows the smallest average value of 22.98% and giving water with a concentration of 40% (200 ml) shows the largest average value of 26 .09%. In comparison, for giving water with a concentration of 60% (300 ml) and without size, each gives an average value of 25.3% and 22.99%.

The results of the calculation of the observed parameters (stem diameter, plant height, number of leaves, leaf area and transpiration) on patchouli plants *(Pogostemon cablin)* in Batu Putih Village, Batu Putih District, North Kolaka Regency with the provision of water content shown on Table 2.

Based on the study's results in table 1, giving water with a concentration of 100% (500 ml) shows the smallest average value of 22.98% and giving water with a concentration of 40% (200 ml) shows the largest average value of 26 .09%. In comparison, for giving water with a concentration of 60% (300 ml) and without size, each gives an average value of 25.3% and 22.99%.

Table 2. The results of calculating the growth parameters of patchouli (*Pogostemon cablin*) at different soil water content for 6 weeks of observation.

No	Parameter	Test	Treatment of groundwater content			
			P0	**P1**	**P2**	**P3**
1	Rod diameter (cm)	1	1.04	1.23	1.21	1.02
		2	1.19	1.40	1.06	1.14
		3	0.38	1.37	1.06	1.04
	Average		0.87	1.33	1.11	1.06
2	Plant height (cm)		P0	P1	P2	P3
		1	49.1	53.6	48.2	50.1
		2	51.4	54.2	49.2	47.1
		3	52.7	51.6	48.7	46.7
	Average		51.06	53.13	48.7	47.96
3	Number of leaves (strands)		P0	P1	P2	P3
		1	32	49.3	51.6	30.3
		2	40.3	58.6	31.3	38
		3	54	62.3	25.3	28.3
	Average		42.1	56.73	36.06	32.3
4	Leaf area (cm2)		P0	P1	P2	P3
		1	12.2	17.4	9.1	10.1
		2	13.9	15.7	7.4	8.9
		3	12.7	14.1	10.5	7.2
	Average		12.93	15.73	9	8.73

Note: P0 = watering without measure, P1 = watering 500 ml, P2 = watering 300 ml, P3 = watering 200 ml.

Furthermore, the results of the ANOVA test on rod diameter patchouli plant (*Pogostemon cablin*) shown on Table 3 below.

Table 3. The results of the ANOVA test on the effect of soil water content on the growth of the stem diameter of patchouli (*Pogostemon cablin*).

Source of diversity (SK)	Degrees of freedom (DB)	Sum of squares (JK)	Middle square (KT)	Fcount	Ftable	
					5%	1%
Group	2	0.12	0.06	1.5ts	5.14	10.92
Treatment	3	0.33	0.11	2.75ts	4.76	9.78
Error	6	0.25	0.04			
Total	11	0.7				

Note: ts: not significant

Furthermore, the ANOVA test results on the patchouli plant height (P. cablin) are shown on Table4 following.

Table 4. ANOVA test results the effect of soil water content on the growth of patchouli plant height (*Pogostemon cablin*).

Source of diversity (SK)	Degrees of freedom (DB)	Sum of squares (JK)	Middle square (KT)	Fcount	Ftable	
					5%	1%
Group	2	0.61	0.305	0.107ts	5.14	10.92
Treatment	3	49.78	16.59	5.82*	4.76	9.78
Error	6	17.15	2.85			
Total	11	67.54				

Note: ts: not significant
* : significant

The next results ANOVA test on the number of patchouli leaves (*P. cabin*) is shown in Fig Table 5 below.

Table 5. ANOVA test results the effect of soil water content on the increase in the number of leaves of patchouli (*Pogostemon cablin*).

Source of diversity (SK)	Degrees of freedom (DB)	Sum of squares (JK)	Middle square (KT)	Fcount	Ftable	
					5%	1%
Group	2	6.07	3.03	0.02ts	5.14	10.92
Treatment	3	1044.37	348,12	2.73ts	4.76	9.78
Error	6	762.91	127.15			
Total	11	1813.35				

Note: ts: not significant

Table 6. ANOVA test results the effect of soil water content on leaf area of patchouli (*Pogostemon cablin*).

Source of diversity (SK)	Degrees of freedom (DB)	Sum of squares (JK)	Middle square (KT)	Fcount	Ftable	
					5%	1%
Group	2	2.4	1.2	0.52ts	5.14	10.92
Treatment	3	101.52	33.84	14.90**	4.76	9.78
Error	6	13.64	2.27			
Total	11	117.56				

Note: ts : not significant
**: very significant

2. Discussion

a) Rod Diameter

The results of measuring the stem diameter of patchouli (*Pogostemon cablin*) at 100% soil water content (500 ml) with an average of 22.98% had the best stem diameter growth (1.33 cm) compared to other watering (60%, 40% and no size). In watering with soil water content without measure (P0) with an average of 22.99%, the growth of the smallest stem diameter was 0.87 cm. The availability of sufficient ground water can meet the water needs in the photosynthesis process, increasing the diameter of the plant stems. However, stem diameter growth will decrease due to the lack of water in plants. Thing this in line with research conducted by Setiawan (2013), that patchouli (*Pogostemon cablin* Benth*)* which given treatment content. Different ground waters have smaller stem diameters at 20% watering compared to 60% watering and 100%.

The results of the ANOVA test in Table 3 show that the treatment of soil water content did not have a significant effect (calculated F value < F table value) on the growth of patchouli (*P. cabin*) stem diameter until the sixth week. It is suspected that nutrients more influence stem diameter growth in the soil, such as nitrogen (N) and phosphorus (P), so there is no significant difference in water treatment between each treatment. According to Hasibuan (2012), Plants require quite a lot of essential nutrients. If the nutrients are lacking, they can inhibit and interfere with plant growth, both vegetative and generative. Zulmi (2014) also stated that the stem is an area of accumulation of growth, especially in younger plants. Nutrients can encourage plants vegetative growth, such as the formation of chlorophyll in leaves, which will stimulate the rate of photosynthesis. The higher the photosynthesis rate, the more significant increase in stem diameter.

b) Plant height growth

The results of measuring the height of patchouli (*Pogostemon cablin*) at 100% (500 ml) soil water content with an average of 22.98% have growth tall which most good (53.13 cm) compared to other watering (Table 2). On watering with soil water content, 40% (200 ml) with an average of 26.09% had the smallest height growth of 47.96 cm. The height of a plant is directly proportional to the amount of water available. The amount of water absorbed by the roots is highly dependent on groundwater. This is evident from the soil water content of 40% (200 ml) is not enough to encourage the growth of patchouli plant height. Lubis (2011) states that if the plant lacks water, the growth process will be hampered (plants become stunted), and low yields will decrease. Harjadi (2017) states that water availability greatly affects plant height and the development of meristem tissue at the growing point.

The results of the ANOVA test in table 4 show that the treatment of soil water content for the group did not have a significant effect (calculated F value < F table value). However, the treatment significantly affected the growth of patchouli plant height (calculated F value > F table value). *(Pogostemon cablin*) until week 6. It is suspected that plant height is influenced by internal factors of the plant, namely genetics, so there is no significant difference. According to Usrin *et al.* (2018), plant height is dominated by genetic factors. In addition to plant genetic factors, it is also influenced by environmental factors and the availability of N nutrients in soil and water. Special environmental conditions will result in the diversity of plant height growth.

c) Number of Leaves

The results of the number of leaves on patchouli (*Pogostemon cablin*) at different soil water content can be seen in Table 2. Based on the study's results, the plantoncontentwatersoil100% (500 ml) with an average of 22.98% had the best increase in the number of leaves (56.73 strands) compared to the treatment with 60%, 40%, and no size soil water content. This shows that the more significant the soil water content, the greater the number of patchouli leaves increase. The increase in the number of leaves will decrease with the reduced availability of water in the soil. The difference in the number of leaves at different water applications is closely related to the availability of water in the soil, where a lack of water in the soil will cause a water shortage in the soil body plants (Marjenah, 2010). Water is needed by plants, especially during cell division and leaf formation. Lack of water in the plant body when given water with different contents will decrease cell division and leaf formation (Soemartono, 2016).

The results of the ANOVA test in Table 5 show that the treatment of soil water content did not have a significant effect (calculated F value < F table value) on the increase in the number of leaves of patchouli (*Pogostemon cablin*) until the sixth week. It is suspected that the process of photosynthesis strongly influences the increase in the number of leaves by synthesizing organic matter by sunlight to form new leaf blades. This is research conducted by Khusni (2018), which states that leaves lacking sunlight cannot contribute to net photosynthate, so the rate of vegetative growth of plants is inhibited. The process of leaf formation will be hampered.

d) Leaf area

The results of leaf area measurements on patchouli *(P. cablin)* at different water content can be seen in Table 2. In the treatment of contentwatersoil100% (500 ml) with an average of 22.98%, patchouli has a largest leaf (15.73 cm2) compared with the treatment of 60%, 40% and no size soil water content. This shows that the greater the soil water content, the bigger the wide leaf patchouli plant *(P. cablin).* The leaf area development will decrease with decreased water availability in the soil. Thingthisin line with Rahman's (2012) research, the leaf area biggest in patchouli plants occurred in watering with a soil water content of 190 ml. The lowest was on the water with a concentration of 160 ml of soil water content.

The results of the ANOVA test in Table 6 show that the treatment of soil water content for the group did not have a significant effect (calculated F value < F table value). However, the treatment significantly affected plant leaf area (calculated F value > F table value). patchouli (*P. cablin*) until the sixth week. Allegedly, patchouli leaf area is more influenced by external factors such as the intensity of sunlight. This is supported by research by Novinanto (2019), which states that the higher the intensity of sunlight, the higher the leaf area produced. The low light intensity can cause stunted plant growth and narrow leaf area.

E. Conclusion

Based on the study's results, it can be concluded that applying soil water content to patchouli (*Pogostemon cablin*) with different concentrations did not significantly affect the growth parameters of patchouli plants.

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