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THE EFFECT OF WATER SUPPLY ON LEAVES CONTENT OF N, P, AND K OF SOME COFFEE VARIETIES

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ABSTRACT

The Water is important for nutrient uptake mechanisms, namely root interception, diffusion and mass flow. Water is absorbed by plants through the roots together with nutrients dissolved in it, then transported to the top of the plant, especially the leaves through xylem vessels. This research was conducted in the laboratory and greenhouse of the Faculty of Agriculture, Islamic University of North Sumatra, Jalan Karya Wisata, District of Medan Johor, Medan City. The research site laid on ± 25 meters above sea level with a flat topography. This research was conducted from June until completion. The research design is factorial randomized block design (RAK) using 2 factors, namely Variety (V) consisting of 4 levels, namely Robusta coffee BP 936, Gayo Arabica coffee 1, Liberoid Meranti coffee, and Sigararutang Arabica coffee. Watering consists of 4 levels, namely: watering with intervals 1 day twice, once every 2 days, once every 3 days, and once every 4 days. The observed variables were: analysis of the N, P, K content of the leaves. The results showed that the highest N content was found in robusta BP 936, the highest P content was in Gayo 1 arabica, the highest K content was in Gayo arabica 1. An increase in watering intervals for coffee varieties with intervals of 4 days resulted in the highest P and K while the highest N nutrient content was at watering intervals of once every 3 days.

KEYWORDS: Watering Interval, Leaf Content, Coffee varieties.

INTRODUCTION

Coffee is one of the plantation commodities that has a fairly high economic value compared to other plantation crops and has an important role as a source of foreign exchange for the country. Coffee is also as source of income for no less than one and a half million coffee farmers in Indonesia.[1]

Coffee variety refers to a subspecies of coffee. Coffee beans from two different places usually also have different characters, both in terms of aroma (from citrus aroma to earthy aroma), caffeine content, taste and acidity level. These characteristics depend on where the coffee grown, the production process and the genetic differences of the coffee subspecies. There are two types of coffee that have been cultivated in Lampung province, namely Arabica and Robusta.[2]

One of the problems faced on plants propagation through seeds is abiotic stress factors that inhibit the infiltration of nutrients into the seeds. Abiotic stresses such as drought, high salinity, high or low temperatures, soil acidity, have been recorded to reduce world agricultural yields by more than 50%.[3] Drought stress can be caused by lack of water supply in the root area and excessive water demand by leaves due to the evapotranspiration rate that exceeds the water absorption rate even though there is sufficient soil water available.

Lack of water affects all aspects of plant growth, which include physiological, biochemical, anatomical and morphological processes. At the state of water stress, some of leaf stomata will close and inhibit the entry of CO_2 and reduces photosynthetic activity. In addition, lack of water also inhibits protein and cell wall synthesis.[3]

The aim of the study was to determine the effect of water

application on the leaf content of several coffee varieties.

MATERIALS AND METHODS

Place and time of research

This research was conducted in the laboratory and greenhouse of the Faculty of Agriculture, Islamic University of North Sumatra, street Karya Wisata, District of Medan Johor, Medan City. The research site laid on ± 25 meters above sea level with a flat topography.

Materials and Tools

The materials used in this research are Robusta coffee BP 936, Gayo Arabica coffee 1, Liberoid Meranti coffee, and Sigararutang Arabica coffee, Andisol soil, organic fertilizer, water and others materials for this research.
The tools used are measuring cups, *gembor*, plastic rope, bamboo signposts, documentation tools, stationery, tape measure, plank, Beaker Glass, and others tools that support this research.

Research methods

The research design is factorial randomized block design (RAK) using 2 factors, namely :

The first factoris the variety of coffee plants, namely:
V_1= Robusta coffe BP 936
V_2= Gayo Arabica coffe 1
V_3= Liberoid Meranti coffe
V_4= Sigararutang Arabica coffee

The second factoris watering consisting of 4 levels, namely:
P_0= control (watering with intervals 1 day twice)
P_1= Watering at intervals of 2 days
P_2= Watering at intervals of 3 days
P_3= Watering at intervals of 4 days

RESULTS AND DISCUSSION

N content (%)

Plant tissue analysis showed that the nitrogen content of coffee were in nutrient deficiency. Nitrogen content of coffee plants tissue can be seen in Table 1.

Table 1: Plant Tissue Analysis of Nitrogen Content (%).

Treatment	N Tissue (%)	Criteria	Varieties
VIP0	1,80	deficiency	
V1P1	2,30	deficiency	Robusta coffee
V1P2	2,03	deficiency	BP 936
V1P3	2,38	deficiency	
V2P0	1.90	deficiency	
V2P1	1.87	deficiency	Gayo Arabica
V2P2	1.97	deficiency	coffee 1
V2P3	2,14	deficiency	
V3P0	1,65	deficiency	
V3P1	1,75	deficiency	Liberoid Meranti
V3P2	1,50	deficiency	coffee 1
V3P3	1.48	deficiency	
V4P0	1,93	deficiency	
V4P1	1,58	deficiency	Sigararutang
V4P2	1,68	deficiency	Arabica coffee
V4P3	2,28	deficiency	

Note : Very less = < 1,60
Deficiency = 1,60-2.49
Optimum = 2,50-3,50
Excessive = > 3,50

In Table 1, the results of laboratory analysis showed that all treatments were in N nutrient deficiency. The highest N (Nitrogen) content found in treatment VIPI, namely 2.38%, and the lowest level of N content found in treatment V3P3, namely 1.48%. N content also affected by watering applied to the soil, the more adequate water needs in the soil, the higher the nutrient content in the soil that supports the growth of these plants.

Ecophysiological Adaptation to Dry Tropical Climates

Ten types of plants studied, each of which has a distinctive leaf anatomical structure. Some types have structures that are not shared by other types, including the sclerenchyma sheath, secretory channels and cells and oxalate crystals. All plant species studied did not have a bundle sheath, which is a layer of cells that is usually large around the transport bundle.

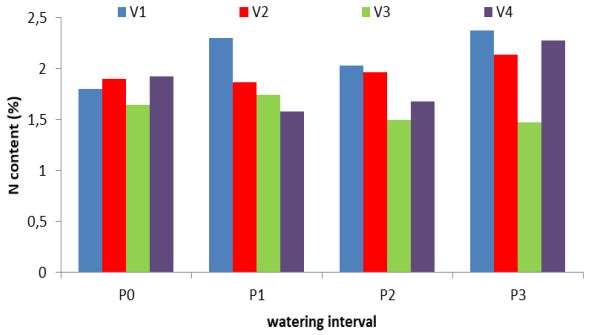

Figure 1: Comparison of N (Nitrogen) nutrient analysis for each treatmen.

In the diagram above, it can be seen that the highest level of nutrient content is in variety V1 (Robusta coffee BP 936) with watering intervals P3 (watering at interval 4 days), and the lowest N content is in variety V3 (Liberoid Meranti Coffee 1) with P3 watering interval (watering at interval 4 days). The increased ability of the soil to supply N is related to the ability of the given organic matter to provide N for plants. Organic matter is a source of N, P and S nutrients for plants, thus increasing organic matter means increasing the availability of these elements for plants. Mengel, et al., (2001) stated that when macronutrients in the soil increase, the amount that can be absorbed by plants will also increase, accompanied by the formation of organic compounds in plant tissues. In addition, the volume of photosynthate that can be produced by plants is not only determined by the absorption of sunlight, but also by the availability of raw materials in the ribosomes obtained through the absorption of nutrients from the soil. Improvement of nutrient absorption is also influenced by improvement of soil pH.[4]

The plant tissue, especially in leaves that lack chlorophyll, will cause chlorosis, namely pale yellow to brown leaves. This is an indication of nutrient deficiency in the leaves. The N content can be increased by adding nutrients and also watering, especially with rain water, but the N content can be washed out at any time due to excessive watering of plants.

The role of water as nutrients solvent in the soil causes plants to easily take up nutrients as food through the roots and at the same time transport nutrients to the parts of the plant that need them through the xylem vessels. Lack of water will interfere physiological and morphological activities, resulting in cessation of growth and drought stress which will affect the size and intensity of plants in both the vegetative and generative phases. Haryati (2003) state that continuous water deficiency will cause irreversible changes (irreversible) and in turn the plant will die.[5]

In a study conducted by Noertjahyani and Santoso (2004), the response of N content in lettuce leaves due to water sources showed different patterns at various levels of watering frequency, namely the N content that was watered with water once every 2 days was higher than plants watered at intervals 2 times a day and every 3 days. This indicates that the N content increased significantly due to differences in water application intervals.[6]

P content (%)

Plant tissue analysis showed that the phosphate content of coffee was in optimum conditions. Phosphate content of plant tissue in coffee can be seen in Table 2.

Table 2: Plant Tissue Analysis of Phosphate Content (%).

Treatment	Tissue P(%)	Criteria	Varieties
VIP0	0,22	Optimum	
V1P1	0,17	Optimum	Robusta coffee
V1P2	0,24	Optimum	BP 936
V1P3	0,19	Optimum	
V2P0	0,22	Optimum	
V2P1	0,21	Optimum	Gayo Arabica
V2P2	0,41	Optimum	coffee 1
V2P3	0,28	Optimum	
V3P0	0,22	Optimum	
V3P1	0,17	Optimum	Liberoid Meranti
V3P2	0,19	Optimum	coffee 1
V3P3	0,22	Optimum	
V4P0	0,20	Optimum	
V4P1	0,22	Optimum	Sigararutang
V4P2	0,25	Optimum	Arabica coffee
V4P3	0,22	Optimum	

Note:

Very less	=<0,11
Deficiency	= 0,11-0.14
Optimum	= 0,15-0,35
Excessive	= > 0,35

In Table 2, it can be seen that the results of the laboratory analysis showed that P (Phosphate) plant tissue was in optimum condition. The highest P content of plant tissue was found in treatment V2P2, namely 0.41%, and the lowest P was in treatments V3P1 and V1P1 with a total P percentage of 0.17. The P content also affected by watering to the soil. The more adequate water needs in the soil, the more the nutrient content in the soil to supports the growth of these plants. Ariffin (2002) suggests that plants that lack water will trigger the formation of abscisic acid inhibitory hormones and growth stimulating hormone inhibitors. Lack of water also reduces the availability of nutrients for plants because the amount of water in the soil will affect the concentration of nutrients in the soil solution and the rate of movement of nutrients to the roots through diffusion and mass transport.[7]

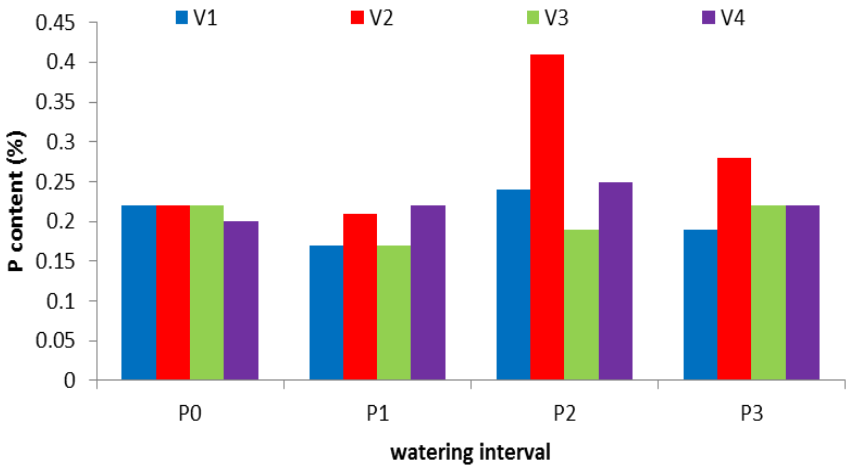

Figure 2: Comparison of Phosphate Content (%) analysis for each treatment.

In the diagram, it can be seen that the highest level of P nutrient content was found in variety V2 (Gayo Arabica Coffee 1) with P2 watering intervals (watering at intervals of 3 days), and the lowest P content is in variety VI (Robusta Coffee BP 936) with P1 watering interval (watering at interval 2 days). In the P content variable, combination of treatments V2P2 resulted in higher leaf P content than the other treatments. This is as a result of the sufficient level of water availability for plants. For plants, water functions as a solvent to dissolve the nutrients provided or available in the soil, which are then used for the photosynthesis process. With sufficient availability of nutrients, photosynthesis takes place well and photosynthate produced is also a lot and among these photosynthates is then used for leaf formation. However, this large number of leaves is not accompanied by an increase in leaf area, this is thought to be a result of the focus of plant growth that leads to the number of leaves. Ritche *in* Mapegau (2006) states that a sensitive process that can occur as a result of lack of water is cell division. This can be interpreted that plant growth is very sensitive to water deficit (stress) because it can stop cell division and result in smaller plants.[8] Previous research by Minor *in* Mapegau (2006) found that the effect of water stress on plant growth is reflected by smaller leaves.[8] According to Poerwowidodo (1992) *in* Usnawiyah (2013), P is an essential nutrient element for plants with a function as a transfer of energy to the aspect of genes that cannot be replaced with other nutrients. Insufficient supply of P causes plants not to grow optimally or their yield potential is not maximized or unable to complete the normal reproductive process.[9]

K Content (%)

Plant tissue analysis showed that the potassium content of coffee was in various state. The content of plant tissue potassium levels in coffee plants can be seen in Table 3.

Table 3: Plant Tissue Analysis of Potassium Content (%).

Treatment	Tissue (%)	Criteria	Varieties
VIP0	1,96	deficiency	Robusta coffee BP 936
V1P1	1,94	deficiency	
V1P2	2,13	Optimum	
V1P3	1,92	deficiency	
V2P0	2,37	Optimum	Gayo Arabika coffee 1
V2P1	2,01	Optimum	
V2P2	2,01	Optimum	
V2P3	3,79	Excessive	
V3P0	1,29	Very Less	Liberoid Meranti coffee 1
V3P1	1,16	Very Less	
V3P2	1,56	deficiency	
V3P3	1,37	Very Less	
V4P0	0,83	Very Less	Sigararutang Arabica Coffee
V4P1	1,90	deficiency	
V4P2	1,99	deficiency	
V4P3	1,98	deficiency	

Note:
Very less＝<1,50
Deficiency = 1,50-1,99
Optimum = 2,00-3,00
Excessive = > 3,00

Table 3, it can be seen that the results of laboratory analysis for K content on coffe plant tissue showed a mixed result. The highest content was found in treatment V2P3 which was 3.79% indicating excessive level, and the lowest K content was in treatment V4PO with a total K percentage of 0.83%. The more adequate water needs in the soil, the more the nutrient content in the soil that supports the growth of the plant.

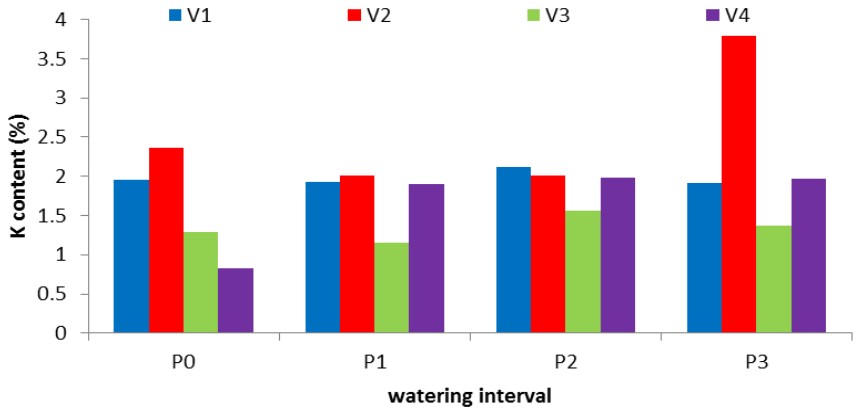

Figure 3: Comparison of K Content (%) analysis for each treatment.

In the diagram above, it can be seen that the highest level of K nutrient content was found in variety V2 (Gayo Arabica Coffee 1) with P3 watering intervals (watering at intervals of 4 days), and the lowest K content is in variety V3 (Liberoid Meranti Coffee 1) with P1 watering interval (watering at interval of 2 days). If the K nutrient content in the soil is high, but given a lot of watering, the K element will be easily washed and wasted by water, therefore it is necessary to provide sufficient watering for plant growth.

Nutrient analysis in the laboratory is leaf samples analysis with different varieties. Varieties of gayo arabica coffee have the ability to absorb K elements in the soil. Level of K content in plants is also influenced by the level of K content in the soil and also the nutrients absorption ability in the soil.

Each type of plant has different water requirements. Sulistyono (2007) states that the water requirement for plants is the volume of water needed to meet the water needs of plants apart from rainfall.[10] The water needs of plants in each growth phase can be determined by the growth rate, type of plant and climatic factors. In this case, it can be determined the available water capacity to fulfill the water needs of plants, and the optimum level of water needs in plants. The need for water in plants is also influenced by the level of water availability and the frequency of watering.[11]

Climate change can affect the available water capacity. Climate change can occur due to global warming so that it can bring up various conditions, one of which is drought stress.[12] In this drought stress condition, not all types of plants have the same ability and can survive, so plants need to adapt to the environment in order to maintain their lives.[13]

CONCLUSION

1. The highest N content was found in variety of robusta coffee BP 936, the highest P content was found in variety Gayo arabica 1 and the highest K content in variety Gayo arabica 1.
2. Watering at intervals of 4 days resulted in the highest P and K nutrient content. The highest N nutrient content was found at watering at intervals 3 days.

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