THE EFFECT OF INORGANIC FERTILIZER AND BIOFERTILIZER ON THE GROWTH OF PATCHOULI PLANT (*POGOSTEMON CABLIN*)

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"I hereby declare this thesis entitled "The effect of inorganic fertilizer and biofertilizer on the growth of patchouli plant" is the result of my research expect as cited in the references. The thesis has not accepted for any degree and is not concurrently submitted in candidature in any other degree"

Signature : ……..
Name : ……..
Date : ……..

I dedicate this to my beloved family and my friends.

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ABSTRACT

The purpose of this research is to study the effect of inorganic fertilizer and biofertilizer to patchouli growth. Fertilizer contain amount of nutrient that need for plant to growth. Different of nutrient in fertilizer give different effect to the growth of Patchouli. DR 2800 spectrophotometer is used to analyze or determination of nitrogen, phosphorus and potassium while boron, zinc, manganese, copper and iron content were done using Atomic Absorption Spectrometry. Harvesting and extraction is started when patchouli is already matured, after 6 month. Oil was extracted using hydro distillation at temperature 100 ^{o}C for about 3 hours. Before the extraction, the leaves have to be dried process using oven at temperature 60 ^{0}C, overnight. The content of nitrogen, phosphorus and potassium is identified as major component in fertilizer or as main nutrient in the fertilizer then heavy metal. The percentage growth of plant with inorganic were 60%, the percentage of plant with biofertilizer were 58% and the percentage growth of control were 50%. The height and the color number of leaves and the dry weight of plant with inorganic also the highest if comparing with plant treated with biofertilizer and control. But for essential oil and the yield, plant with biofertilizer produce the higher yield with percentage of 0.89 while plant treated with biofertilizer and control, both were 0.88% and 0.48%. As a conclusion, the growth of plant which treated with inorganic was the better but plant which treated with biofertilizer was better in producing essential oil.

ABSTRAK

Tujuan utama penyelidikan ini adalah untuk mengkaji kesan baja inorganik dan baja biologi terhadap pertumbuhan pokok Patchouli. Kesan perbezaan pertumbuhan antara setiap pokok yang menggunakan baja yang berbeza akan dapat di lihat melalui jumlah minyak yang terhasil daripada daun bagi setiap pokok. Baja mengandungi nutrisi yang diperlukan oleh tumbuhan yang tidak dapat dibekalkan oleh tanah dan setiap nutrisi akan memberikan kesan yang berbeza kepada kadar pertumbuhan pokok. Dalam kajian ini, alat *DR 2800 Spectrophotometer* digunakan untuk menganalisis kandungan makronutrisi dalam baja manakala alat *Atomic Absortion Spectrometry* digunakan untuk menganalisis kandungan mikronutrisi dalam baja. Kajian ini di jalankan dengan penanaman pokok patchouli yang mana melibatkan aspek kawasan, penyediaan media, air dan pembajaan bagi setiap pokok. Pengestrakan daun patchouli dilakukan selepas daun telah mencapai tahap matang iaitu selepas enam bulan. Kaedah pengestrakan daun yang di gunakan dalam kajian ini adalah kaedah penyulingan menggunakan air yang mana suhu yang di gunakan adalah 100^{o}C selama 3 jam. Melalui kajian ini, didapati bahawa kandungan makronutrisi dalam baja adalah banyak jika di bandingkan dengan kandungan logam berat dalam setiap baja tersebut. Ini menggambarkan bahawa tumbuhan memerlukan lebih banyak kandungan nitrogen,fosforus dan kalium untuk pertumbuhan. Pokok yang dibekalkan dgn baja inorganic mencatat 60 peratus kadar pertumbuhan berbanding 58 peratus untuk pokok dibekalkan dengan biologi dan 50 peratus untuk pokok kawalan. Bagi penghasil minyak, pokok yang dibekalkan baja biologi menghasilkan minyak yang lebih banyak iaitu 0.89 peratus jika dibandingkan dgn pokok yang dibekalkan dengan baja biologi and pokok kawalan iaitu masing-masing 0.88 peratus dan 0.48 peratus. Justeru itu, kadar pertumbuhan bagi pokok yang dibekalkan dengan baja inorganic adalah lagi baik dari segi ketinggian dan berat kering tetapi bagi penghasilan minyak, pokok yang dibekalkan dengan baja biologi adalah yang terbaik.

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AAS	-	Atomic absorption spectrophotometer
AM	-	Endomycorrhizal fungi
ATP	-	Adenosine triphosphate
DNA	-	Deoxyribonucleic acid
EM	-	Ectomycorrhizal fungi
HNO_3	--	Hydrogen Peroxide
JP	-	Jurutera pengajar
KOH	-	Potassium Hydroxide
mA	-	Miliampiere
NADP	-	Nicotinamide adenine
nm	-	Nanometer
ppm	-	Part per million
TKN	-	Total kjedahl nitrogen
β	-	Beta
α	-	Alpha
^oC	-	Degree Celcius

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CHAPTER 1

INTRODUCTION

1.1 Background of study

A fertilizer is a material that is added to soil to put nutrients into the soil and provides nutrients to plants. Fertilizer can be divided into three major categories which are primary nutrients, secondary nutrient and metal. nitrogen, phosphorus and kalium are considered primary nutrients, secondary nutrients include sulfur, Magnesium , calsium and natrium and metal include boron, copper, cuprum, ferum, manganese, and zinc. Metal are essential for plant growth but in small quantities compared to those of primary and secondary nutrients.

Inorganic fertilizers are from non-living sources. Most elements are absorbed by plants as inorganic ions (electrically charged atoms). A plant does not distinguish between ions originating from inorganic or from organic sources. When nutrients are the main interest, inorganic fertilizers are usually favored.

Biofertilizer is the fertilizers used to improve the fertility of the land using biological wastes. Hence the term biofertilizers, and biological wastes do not contain any chemicals which are detrimental to the living soil. They are extremely beneficial in enriching the soil with those micro-organisms, which produce organic nutrients for the soil and help to combat disease

1.2 Patchouli plant (Pogostemon Cablin)

1.2.1 Scientific Classification

Table 1.0: Scientific clarification for Patchouli plant

Kingdom	Plantae
Family	Lamiaceae
Division	Magnoliophyta
Genus	Pogostemon
Class	Magnoliopsida
Species	P. cablin
Order	Lamiales
Binomial name	Pogostemon cablin

1.3 Problem statement

Country likes India, Indonesia and Vietnam have apply patchouli for many uses such as for medical purpose, perfume and aromatherapy. Due to the various uses of patchouli oil, people will think the way on how to produce high amount of oil from the leaves. The growth of leaves is proportional to the growth of the plant growth of leaves is proportional to the growth of the plant and to make the plant growth better, nutrient is needed. Fertilizer gives different effects to the growth of plant according to the amount of nutrient available for example the amount of nitrogen, phosphorus and potassium (major nutrient for plant growth).

Supplement of essential nutrient will produced good quality of leaves thus produce high volume of oil than the one which growth without fertilizer. This experiment will defines the effect of amount of each nutrient that are good for patchouli growth and also the extraction method that used for extract the oil from patchouli leaves.

1.4 Objectives

The main objectives of this research are to study the effect of inorganic and, biofertilizer on the growth of patchouli plant and essential oil production.

1.5 Scope of research

This research is based on experimental studies effects on different amount of nutrient in inorganic fertilizer and biofertilizer to Patchouli growth. In order to achieve the objectives, a few scopes have been identified:

1. Characterize component of macronutrient and micronutrient in inorganic fertilizer and biofertilizer.
2. Study the effect of patchouli's growth after nutrient addition.
3. Studies the effect of fertilizer on producing patchouli's oil by extract the patchouli leaves.

CHAPTER 2

LITERATURE REVIEW

2.1 Fertilizer

Commercial fertilizer is a source of plant nutrient that can be applied to soil nourish crop when the soil cannot supply to total crop requirement.

2.2 Inorganic fertilizer

There are three general categories of inorganic fertilizer: macronutrient (primary) fertilizer, secondary fertilizer and micronutrient fertilizer. Each of the general categories of inorganic fertilizer supplies plants with different nutrient. Macronutrient fertilizer supply primary nutrient, which include nitrogen (N), available phosphate (P), and soluble potash or potassium (K).

Secondary fertilizer supply secondary nutrient to plant including calcium (Ca), magnesium (M) and sulfur (S). Example of secondary fertilizer product includes calcium chloride, calcium chelate and magnesium chelate. Micronutrient fertilizers supply plant with boron, chloride, cobalt, iron, manganese, sodium and zinc. For example, zinc micronutrient supply zinc, iron micronutrient supply iron and mixes supply one or more of the micronutrient. Example of micronutrient product includes manganese oxides and zinc sulfate.

2.3 Biofertilizer

Biofertilizer refers to products using live organisms as expanded definition of fertilizer. Today's main biofertilizer product is specified additives that includes live organisms or dormant spores, e.g. bacteria (including actinomyces), fungi, and algal. When applied onto crops, it has the effect of supplying specific nutrition to plants, so it is also known as microbial fertilizer. These effects include enhancing the supply volume and total volume of plants' nutritional elements, stimulate plant growth, or stimulate plants' absorption of nutritional elements.

In other words biofertilizer is a substance which contains living microorganisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. The growth of plant is promoting rhizobacteria as biofertilizers. The production and use of biofertilizer is proposed, to improve yield of crops by using root nodule bacteria (rhizobia), mycorrhizal fungi, and other microorganisms that are able to increase availability of plant nutrients from the soils.

Biological fertilizers promote plant growth in a number of ways such are aid in replenishing and maintaining long-term soil fertility by providing optimal conditions for soil biological activity, suppress pathogenic soil organisms, degrade toxic organic chemicals, stimulate microbial activity around the root system significantly increasing the root mass and improving plant health, increase the available nitrogen for plants far in excess of their own content by stimulating the growth of natural soil microorganisms. These soil microorganisms metabolize nitrogen from the air to multiply. When they die (some microorganisms have a life-span of less than 1 hour) the nitrogen is then released to the soil in a form that is readily available to the plants. Also interact with other soil organisms and biodegradable components in the soil to supply essential nutrients such as nitrogen, phosphorus, calcium, copper, molybdenum, iron, zinc, magnesium and moisture to the plants, aid in solubilizing manganese.

Biofertilizer promotes fertilizer also by Produce thicker, greener and healthier crops, produce plants with increased sugar flavor and nutrient content, improve seed germination, reduce input costs, aid in the development of root systems that produce stronger healthier plants more able to resist pests and drought conditions, increase soil microorganism populations which in turn increases the uptake of nutrients from soil to plants, improve oxygen assimilation in plants, aid in rebuilding depleted soil, aid in balancing soil pH and aid in reducing soil erosion.

2.3.1 Relationships between Biofertilizers and Mycorrhizal Fungi

Plant roots secrete “food” for bacteria and fungi, which attracts nematodes (worms) to the roots, because nematodes eat bacteria and fungi, and excrete Nitrogen, Sulphur and Phosphorus in a form that the plants can use [1]. The nematodes only keep 1/6 of the nitrogen that they process, 5/6 is excreted to the plant. Once the nematodes have excreted the nutrients, the hyphae of the mycorrhizal fungi pick them up and transfer them into the plant. Because of this symbiotic relationship, the least leachable form of Nitrogen you can apply is bacteria and fungi, and bacteria are the most Nitrogen-rich organisms on earth [1]. Mycorrhizae hyphae pick up more nutrients than just those excreted by nematodes, however. One of the most beneficial properties of mycorrhizae is its ability to “mine” the soil great distances from the roots for nutrients, especially those, such as Phosphorus, that are poorly mobile in the soil. Mycorrhizae also assist in picking up water further away from the roots, and block pest access to roots [2].

Mycorrhizae also benefit plants indirectly by enhancing the structure of the soil. AMhyphae excrete gluey, sugar-based compounds called Glomalin, which helps to bind soilparticles, and make stable soil aggregates. This gives the soil structure, and improves air and water infiltration, as well as enhancing carbon and nutrient storage [2].Most natural, undisturbed soils have an adequate supply of mycorrhizae for plant benefits; however, the following practices can reduce mycorrhizae populations to inadequate levels [2]. Erosion, Grading, Excavation, Occupation with non Mycorrhizal plants (weeds) and loss of original topsoil. The best way to be sure that you have appropriate mycorrhizal levels in your soil is to get a soil sample analyzed for mycorrhizal presence. To maintain healthy mycorrhizae populations [2], do not apply too much phosphorus, as high levels will limit mycorrhizal effectiveness, low to moderate levels, or slow-release phosphorus will maximize plant benefits, limit fungicide use, as some fungicides damage AM fungi and limit soil disturbance, as disruption of the hyphae in the soil limits water and nutrient movement into the root.

2.3.2 Mycorrhizal Fungi

Mycorrhizal fungi form a bridge between the roots and the soil, gathering nutrients from the soil and giving them to the roots. There are two major types of mycorrhizae: Ectomycorrhizal Fungi (EM) and Endomycorrhizal Fungi (AM).

Endomycorrhizae are the most common, and are found in grasses, shrubs, some trees, and many other plants. Ectomycorrhizal Fungi are usually specific to a certain host species, but most species of endomycorrhizae will form relationships with almost any Endomycorrhizal Fungi host plant, and is therefore much easier to specify [2].

These plant families are well known as weeds. Therefore, if you do not ensure an adequate supply of mycorrhizae, you may inadvertently inhibit growth of desirable species and allow for rapid growth of undesirable species. Biofertilizer contains a wide range of naturally chelated plant nutrients and trace elements, carbohydrates, amino acids and other growth promoting substances.

2.4 Nutrient in fertilizer

There are 16 nutrients element required to grow crop. Three essential nutrient are carbon (C), hydrogen (H) and oxygen which taken up from atmospheric carbon dioxide and water. The other 13 nutrients were taken from the soil and usually grouped as macronutrient and micronutrient. Macronutrient which are nitrogen (N), potassium (K) and phosphorus (P) are utilized in the largest amounts by crop. Micronutrient such as iron (Fe), manganese (Mn), zinc (Zn), copper (Cu) and boron (B) are required in even smaller amount than macronutrient.

2.4.1 Nitrogen

Of the three major nutrient, plant required nitrogen in the largest amounts. Nitrogen promotes rapid growth, increase leaf size and quality, hastens crop maturity, and promotes fruit and seed development. Because of nitrogen constituent of amino acids, which are required to synthesis proteins and other related compound, its plays a role in almost all plant metabolic processes. Nitrogen also an integral part of chlorophyll manufacture through photosynthesis. Deficiency symptom of nitrogen generally appear on the bottom leaves first, the lower leaves on the tips turn brown, usually disintegrate, and fall off.

2.4.2 Phosphorus

Normal plant growth cannot be achieved without phosphorus. It is constituent to nucleic acid, phospholipids, the coenzyme DNA and NADP, and most importantly ATP. Its activates coenzyme for amino acid production used in protein synthesis, it decomposes carbohydrates produce in photosynthesis and it is involved in many other metabolic processes required for normal growth, such as photosynthesis, glycolysis, respiration, and fatty acid synthesis. Phosphorus deficient plants are characterized by stunted growth, and reddish purple leafs tips and margin. When soil is cool, less phophorus is available for plant uptake.

2.4.3 Potassium

Potassium is essential for photosynthesis, increase disease resistance, regulates opening and closing of stomates, improve firmness, texture, size and color fruit crop and increase the oil content of oil crop. Potassium deficient plants exhibit chlorosis (loss of gree color) along the leaf margin or tips starting from bottom leaves and progressing up the plant. In severe cases, the whole plant turn yellow, and the lower leaves fall off. As with other nutrient, lack of potassium causes stunted