Faculty of Resource Science and Technology

GROWTH OF *PONGAMIA PINNATA* (L.) PIERRE SEEDLINGS UNDER DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS

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Growth of *Pongamia pinnata* (L.) Pierre Seedlings under Different Levels of Nitrogen and Phosphorus

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Approval Sheet

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Declaration

I am Lo Nyuk Thin third year student from Plant Resource Science and Management Programme from the faculty of Resource Science and Technology hereby declare that all the work done in writing, and producing the report for this project is done by myself under my supervisor Prof Dr Hamsawi Sani and co-supervisor Dr Mohd Effendi Wasli until the report is completed.

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(Lo Nyuk Thin) Dated:

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6. T3 – N_0P_2
7. T4 – N_1P_0
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11. T8 – N_2P_1
12. T9 – N_2P_2
13. T10 – N_3P_0
14. T11 – N_3P_1
15. T12 – N_3P_2
16. N_0 – 0mg/L of ammonium nitrate
17. N_1 – 100mg/L of ammonium nitrate
18. N_2 – 200mg/L of ammonium nitrate
19. N_3 – 300mg/L of ammonium nitrate
20. P_0 – 0mg/L of disodium phosphate
21. P_1 – 50mg/L of disodium phosphate
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Growth of *Pongamia pinnata* (L.) Pierre Seedling under Different Levels of Nitrogen and Phosphorus

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ABSTRACT

Pongamia pinnata or commonly known as pongam founds to be a valuable trees especially in economic and medicinal value for example as a source of biodiesel. Pongam has been planted widely in India to produce biodiesel. Due to its ability to absorb heat from the air; this tree has been used as ornamental trees at the roadside and housing area. In order to produce a success stock production, growth seedling of *P. pinnata* was conducted to observe and record the growth performance. There are 12 treatments involve in this study which involved treatment of nitrogen, phosphorus, and combination of both N and P where N_0 is 0mg/L N, N_1 is 100mg/L N, N_2 is 200mg/L N, N_3 is 300mg/L N, P_0 is 0mg/L P, P_1 is 50mg/L P, and P_2 is 100mg/L P. The parameter involve are height, stem diameter, number of leaf, total leaf area, deficiency symptoms, dry root weight (DRW), dry shoot weight (DSW), and root shoot ratio. N_3P_1 was found to have given better result in height, number of leaf, and total leaf area which aids in the increase of yields for the oil extraction for biodiesel production.

Keywords: *Pongamia pinnata*, seeds germination test, media chemical analysis, nitrogen, phosphorus, cocopeat, growth measurement

ABSTRAK

Pongamia pinnata juga dikenali sebagai pongam merupakan sejenis pokok yang mempunyai nilai dari segi ekonomi and perubatan contohnya sebagai sumber biodiesel. Pongam telah ditanam secara meluas di India bagi menghasilkan biodiesel. Keupayaan pongam untuk mengurangkan haba di udara, menyebakan pokok ini ditanam sebagai tanaman hiasan di tepi jalan dan kawasan perumahan. Dalam usaha menghasilkan anak benih yang berkualiti, pembesaran anak benih pongam telah dijalankan dengan memerhati and merekod pembesarannya. 12 jenis rawatan telah dijalankan iaitu melibatkan rawatan nitrogen, fosforus, dan gabungan N dan P dimana N_0 ialah 0mg/L N, N_1 ialah 100mg/L N, N_2 ialah 200mg/L N, N_3 ialah 300mg/L N, P_0 ialah 0mg/L P, P_1 ialah 50mg/L P, dan P_2 ialah 100mg/L P. Parameter yang berkaitan dalam kajian ini ialah ketinggian, diameter, bilangan daun, luas daun, warna daun, berat akar kering (DRW), berat daun dan batang kering, dan ratio akar, dan daun dan batang. N_3P_1 didapati menghasilkan pokok yang tinggi, bilangan daun yang banyak, dan luas permukaan daun yang tinggi dan ianya sesuai untuk mengeluarkan biji yang banyak untuk diekstrak bagi menghasilkan biodiesel.

Kata Kunci: Pongamia pinnata, percambahan biji benih, analisis sifat media, nitrogen, fosforus, hampas kelapa, penukuran percambahan.

1.0 INTRODUCTION

Recently, researchers were carrying out their study to find the best alternative fuel sources from plants. *Pongamia pinnata*, was known to have the same potential. *P. pinnata* also known as *Millettia pinnata* or commonly knowns as Indian beech or pongam. *P. pinnata* is under family of Fabaceae which formerly is Leguminoseae. It is a shrub and fast growing tree. It is an evergreen tree, can grow up from 15 m to 25 m and spreading branch. In India, *P. pinnata* were planted in large scale due to its high economic value. Besides having potential to produce biodiesel, it is also being used in medicinal purpose which has been use since long time ago (Csurhus and Hankamer, 2010). Pongam was reported to be use in traditional medicines in India and neighbouring regions (Scott et al., 2008). Pongam is valuable tree because whole parts of the tree can be utilized for various purposes and current research found that its seed oil has potential to be processed into biodiesel. Pongam were widely planted nowadays especially for urban landscaping, and resource for agroforestry (Scott et al., 2008). Other than that, pongam can help in controlling soil erosion because it has a dense network of lateral roots and it is highly tolerant of salinity. Nowadays, they are becoming very popular in the developing countries for various purposes.

P. pinnata is native to humid and subtropical environments. Mature pongam can withstand waterlogged and slight frost. It can grow at high temperatures from 27^{o}C to 38^{o}C, and low temperature from 1^{o}C to 16^{o}C (Sangwan et al., 2010). Pongam is easily established either can be direct sowing, or stump cutting, propagation by branch cutting and root sucker (Daniel, 1997). Germination of pongam seeds is in within two weeks after sowing (Daniel, 1997). Transplanting of the seeds should be taken after the seedlings reach about 60cm height (Daniel, 1997). Pongam is a nitrogen fixing plants which means it can convert nitrogen gas from the

surrounding into ammonium by the helps of Rhizobium bacteria (Schalau, 2012). This process takes place in the nodules which can only found in legume plants. Pongam has high contains of nitrogen especially in its fruits (Sangwan et al., 2010).

In order to produce the best planting material for higher productivity, the seeds of pongam should be well collected and stored. *P. pinnata* seeds has germination rate from 60 to 89 percent and need to be stored well to maintain the fertility (Parthiban et al., 2010). Based on Parthiban et al (2010), the seeds of pongam can maintain its viability when stored it in the air tight containers. Besides, application of the fertilizer is important to provide sufficient and appropriate mineral nutrient to the plants. Nitrogen, Phosphorus, and Potassium (NPK) fertilizer in various ratios has been widely used in the nursery. Nitrogen (N), phosphorus (P), and potassium (K) are the most important mineral nutrient for healthy seedling growth. The need for the correct amount of nutrient depend on the potting media use to raise the seedling or the site where the species are planted. There were various type of potting media being used in the nursery depends on the purposed. For example, top soil is the most popular potting media although various types of soilless media like composted tree bark, peat moss, and fine coconut husk (cocopeat) are getting popular.

1.1 Problem statement

Nursery stages have played an important role in producing high productivity of planting material of the pongam seedlings. Realizing this potential the species has been planted in large scale for the production of biodiesel in India. Thus, knowledge on the growth of the species especially at nursery stage is important for the success of the planting stock production. This includes finding suitable amount of nutrients that can ensure success growth of pongam.

1.2 Objective

The objective of the experiment is to determine effect of nitrogen and phosphorus on the growth of *P. pinnata* seedling. The specific objectives are to determine the effect of different level of nitrogen and phosphorus either simply or in combinations on plant growth:

i. Plant Height

ii. Stem Diameter

iii. Leaves growth

   a. Numbers of leaves

   b. Surface area of leaves

   c. Deficiencies symptoms

iv. Plant Biomass production

   a. Dry Root Weight (DRW)

   b. Dry Shoot Weight (DSW)

   c. Root Shoot Ratio

2.0 LITERATURE RIVIEW

2.1 *Pongamia pinnata*

Pongamia pinnata commonly known as Pongam in India is a shrub and fast growing tree. Pongam have short branches which spreading into dense of dark green leaves (Figure 1a). The leave is compound, alternate, pinkish-red when young and turn dark green as they are mature. Pongam has white to pink colour of flowers (Figure 1b), smooth pods, and brown seed as shown in figure 1c-d. . The pods is slightly swollen, contain 1 to 2 seeded. The seed is smooth, round shapes and brown in colour. It has gray to grayish brown bark. The tap root is thick, and the lateral root is long and well developed. It is types of legume which belongs to:

Class: Magnoliopsida

Order: Fabales

Family: Leguminoseae/ Fabaceae

Genus: Pongamia

Species: pinnata

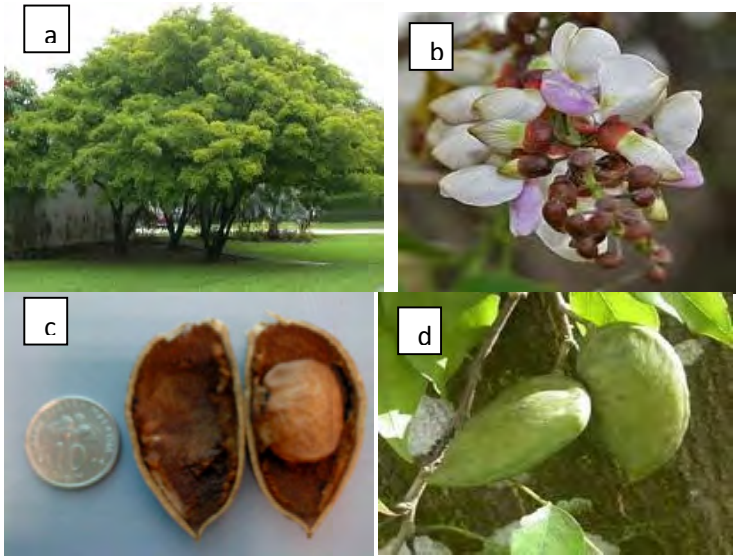

Figure 1a: Trees of *Pongamia pinnata*. **Figure 1b:** Flowers of *P.pinnata*. **Figure 1c:** Seeds of *P.pinnata*. **Figure 1d:** Immatured Seeds of *P.pinnata*.

According to Parthiban et al (2010), the reproduction of pongam is through dispersal of seeds. Mature pongam is around 4-5 years and producing seeds at 4-7 years. The general growth pattern

of pongam is the leaves shed during April, and developed new leaves from May. Pongam will flowers from April to June. The pods will ripen from March to May. The seeds are ripening from February to May. According to Csurhus and Hankamer, single tree producing 9 to 90kg of seeds per annum (2010). It is producing 160kg of seed pods per tree each year (Parthiban et al., 2010). In India, research to develop high-seedling of pongam seeds was carry out to select varieties of pongam that producing high numbers of seedling that can be extract to get the oil for biofuel purposes. Pongam has broad distribution in Indian, Asia, Africa, Pacific and America including the Caribbean. It is native to humid and subtropical environments. Pongam can grow in areas with ranging rainfall from 500 to 2500mm (Csurhus and Hankamer, 2010). *Pongamia pinnata* can grow on various types of soil raging from stony to clayey except on dried sand (Parthiban et al., 2010). Csurhus and Hankamer stated that, pongam prefer a well-drained with high moisture media for example they grow well along the coasts and riverbanks of India, Bangladesh, and Burma (2010). It grows at the temperature within 27^{o} C to 38^{o} C and the minimum temperature it can survive is within 1^{o}C to 16^{o}C. Pongam has high economic and medicinal value. Recently, pongam was found to have large potential as a fuel sources. Due to various types of uses, *P. pinnata* has planted widely.

2.2 The Economic Improtance of *Pongamia pinnata*

Pongamia pinnata seeds recently were found to have potential as a biodiesel (Csurhus and Hankamer, 2010). Research found out that, 40% of the oil can be obtained from the seeds (Parthiban et al., 2010). Since long time ago, pongam has been use by people for different purposes. In the past, peoples use the seeds of pongam to produce oil to make soap, lamp oil and lubricants and also tanning (Csurhus and Hankamer, 2010). Recently, pongam has been cultivated as ornamental and shade tree. In the centered of India, pongam has been widely

planted to stabilize the soil and to reclaim so that it is suitable for farming and building other than for biodiesel purposes. The wood of *P. pinnata* is very valuable for firewood and house furniture. However, it cannot be use as a timber. The leaves of *P. pinnata* when fall and dried can be reused as green manure and improve the fertility of soil (Joshua, 1997). Parthiban et al (2010) stated that, the bark of pongam can be used as string and rope, and paper pulp. While the flower of pongam can be applied for food sources of insects for example honey bees (Parthiban et al., 2010). Every part of the trees organ like flower, bark, seeds, roots, and others can be apply for medicinal purposes. Since long time ago, people use the tree for medicine and others purposes. According to Brijesh et al (2006), the leaves of pongam had proven to have potential against cholera and enteroinvasive bacterial that causing diarrheal. Phytochemical screening also showed that, the leaf of pongam has potential for antibacterial properties (Arote et al., 2009). In India, the seeds had been used for skin ailments (Arote et al., 2009).

Pongamia pinnata trees are broadly branching, and usually known as carbon sink trees. It is being planted as ornamental trees especially at the roadside. Besides, it is also planted to control the soil erosion because it has dense network of lateral roots. Other than that, *P. pinnata* is types of nitrogen fixing plants. It consists of nodules which carry out nitrogen converting by the helps of Rhizobium bacteria (Sangwan et al., 2010). When the trees die, the nitrogen left can be reused by other plants.

2.3 Major plant Mineral Nutrient

There are 13 essential elements needed for healthy, normal and complete growth of plants. Six of the elements are macro element which needed by the plants in large amount for example nitrogen, phosphorus, potassium, calcium, magnesium, and sulphur. Seven of the elements are micro

element which needed in small amount by the plants such as iron, zinc, manganese, copper, boron, chlorine and molybdenum. Deficiency elements showed by the appearance of the plants for example, plant height, number of flowers, flowers quality will reduced if there is deficiency of any of these essential elements (Ruamrungsri et al., 2007). Plant nutrient is applied through organic and chemical fertilizers. Quantity of fertilizer needed by plants graded by % of N, P, and K. N grade by % of total N, % P calculated as phosphorus pentoxide (P_2O_5), and % of water soluble K calculated as K_2O.

2.3.1 Nitrogen

Nitrogen is function as constituent of chlorophyll and protein. This means nitrogen give green color for the plant's leaves. Plants get nitrogen usually from the air. However, nitrogen gas is not in the form that plant can directly used. Some plants like legume helps by Rhizobium bacteria to convert nitrogen gas into ammonium which is available for the plants (Andrews, 1998). Barnhart et al (1997) also stated that adequate amount of nitrogen will helps in response of legume to phosphorous and potassium. Barnhart et al (1997) study also showed that, the yield of the legume pastures has increased when nitrogen is applied. Plants get nitrogen as nitrate and ammonium. Application of N in the form of nitrate will give tall and bigger girth, greener, and high yields (Ghoname et al., 2009). Nitrogen can be obtained from organic nitrogen, urea, ammonium, nitrate, and nitrogen gas (Andrews, 1998). According to Andrews (1998) ammonium is positively charge, while the clay is negatively charge in soil. So, ammonium will stick with clay which causes it not available for the plants and leach during heavy rains (Andrews, 1998). Nitrogen fertilizer can be applied separately to prevent nitrogen losses before the crops require during crop uptake (Maguire and Alley, 2009). Deficiency of nitrogen can be

observed when the presents of chlorotic symptoms. The old leaves will turn from green to yellowish green in colour.

2.3.2 Phosphorous

Phosphorous fertilizer is the main nutrient for the stimulation of early growth of plants. When there is lack of phosphorous in the soil, plants growth will be slow down, the chlorophyll concentration will be too high and causes the leaves to become dark green. Phosphorus can increase both yield and resistance to diseases of plants (Barnhart et al., 1997). Phosphorous also involved in stimulation of root growth (McKenzie & Middleton, 1997). So, the plant will be able to explore further into soil to gain more nutrients and moisture. Phosphorous can be found from the soil and fertilizer. Some can be found in microorganism in soil (McKezie & Middleton, 1997). Microorganisms compete with plants to get phosphorous when there is low phosphorus in soil. However, phosphorous will return to the soil when the microorganism is die (McKenzie & Middleton, 1997). Hague and Mohamed-Saleem (n.d.) stated that phosphorous is the most important nutrient in legumes plants as it can helps to increase nodulation and nitrogen content of the legumes.

2.4 Potting Media

Nowadays, soilless potting media has been widely used especially for large scale plantation. Example of soilless media is coco peat, composted sawdust, peat moss and others. Soilless media is easy and cheap to get as compared to soil. However, topsoil is still famous as potting media in the nursery although it is hard to find the best quality soil media. Soilless media is preferably nowadays because it has capability to be use in various types of purposes in the nursery. Soilless