UNIVERSITI TEKNOLOGI MARA

THE EVALUATION OF ALUMINIUM TOXICITY TOLERANCE ON DIFFERENT VARIETIES OF OIL PALM (*Elaeis guineensis* L. jacq) SEEDLINGS UNDER HYDROPONIC CONDITIONS

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ABSTRACT

Aluminium (Al) toxicity is one of the problems experienced by crops cultivated on acid soil, resulting in root growth inhibition and indirectly affects the nutrient absorption capability of a crop. Al becomes soluble in soil solution at pH less than 5.5 and unavailable for plant uptake. Since Malaysia was renowned for its acidic soils and oil palm as one of the major crops, it is significant to identify the oil palm variety or hybrid affected by Al toxicity. Hence, this study was conducted to examine the effects of Al toxicity on the root morphology, leave growth morphology, chlorophyll content, bole diameter, and the root ability for nutrient uptake of different oil palm varieties namely the GH500, Calix600, HRU, and Guthrie. This study also aims to analyze the tolerance level of these oil palm varieties towards Al toxicity and finally to evaluate the most tolerant oil palm varieties toward high Al concentration. A water culture system using Hoagland nutrient solutions was used in this study to ease the observation of oil palm seedling root growth. In this study, four concentrations of Al act as treatments, specifically 0 μM (control),100 μM, 200 μM, and 300 μM with four replications for each treatment. The findings showed a 66.15% and 61.54% reduction in root growth of GH500 oil palm seedling when the seedling was treated in 200 μM and 300 μM Al concentrations, respectively. In contrast, the HRU and Guthrie varieties exhibit tolerance to high Al concentration. Next, all varieties show a decreasing pattern in shoot development when treated with high Al concentration, where a severe reduction was observed for Guthrie seedling at 100 μM and 300μM Al concentration. Consistent shoot growth of GH500 and Calix600 seedling was detected as compared to the other two oil palm varieties. A reduction of 40% in bole diameter size of HRU seedling was observed at 300 μM Al concentration whereas a 67.85% and 56.00% reduction in leaf's chlorophyll content was recorded in GH500 and HRU seedlings, respectively. The root biomass of GH500, Calix600, and HRU were reduced up to 66.67%, 63.16%, and 60.94% at high Al concentration, respectively, whereas a Guthrie seedling contrarily shows a consistent weight. Additionally, the HRU shoot biomass was decreased severely in this study. A 48.72% reduction was recorded in potassium concentration in the root Guthrie seedling. Reduction in phosphorus concentration was also recorded in the root of Guthrie variety at 300 μM Al concentration, accompanied by a decreasing pattern of calcium and magnesium. Potassium content in the shoot of Calix600 seedling was increased as the concentration of Al increased, showing a positive correlation. A drastic reduction of phosphorus content in the shoot was recorded in GH500, Calix600, and HRU seedlings. At 30 μM Al concentration, there was a 33% reduction of calcium content in the shoot for Guthrie seedling. The consistent magnesium content in the shoot was observed for GH500, Calix600, and HRU seedling. This study suggested that GH500 oil palm seedling has the lowest tolerant level towards high Al.

Keyword: Oil palm seedling, aluminium toxicity, hydroponic

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CHAPTER ONE
INTRODUCTION

1.1 Background of The Study

Oil palm has been cultivated around the globe which accounted 5.5% from the 10 major oilseeds crops. This has contributed 32.0% of global oils and fats output in the year 2012 (Oil World 2013). Among the producer of palm oil around the world, 85% of palm oil produced by Indonesia and Malaysia. In general, oil palm can be cultivated on a wide range of soils. Oil palm and rubber are mostly cultivated on Oxisols and Ultisols type of soil with outstanding management practices. In a study on the suitability of soils for oil palm cultivation in Southeast Asia by Mutert (1999), more than 95% of oil palm in Southeast Asia are grown on low fertility and acidic soils. Mutert (1999) also stated in his study that the soil suitability for oil palm cultivation was influenced by two factors which are the physical and chemical characteristics of the soil. Oil palm cultivation requires a humid tropical climate and it grow better in an area with temperature ranging from 22°C up to 33°C. Oil palm also requires even distribution of 2,500 to 4,000 mm rainfall per year. Goh *et al.,* 2011, have listed six main elements of climate that determine the oil palm performance which include solar radiation intensity and duration, rainfall, air temperature, relative humidity and vapour pressure deficit, evaporation rate, and wind.

It is about 72% of land area in Malaysia is occupied by Ultisols and Oxisols which containing kaolinite, gibbsite, goethite and hematite in the clay fractions (Shamsuddin and Noordin 2011). However, these soils are often deep, red friable and containing high iron (Fe) and aluminium (Al) oxide. Oxisols and Ultisols soils also have low to very low cation exchange capacity (CEC).

Aluminium toxicity is a major constraint that could limit the plant development and eventually affecting the crops yield. A preliminary research by Cristancho *et al*. (2007), there is close relationship between exchangeable Al and root density of mature oil palm. The most observed symptom of Al toxicity in plants is the inhibition of root growth. Study by Cristancho *et al*. (2011) showed there is significant interaction between the Al