

IDENTIFIKASI DAN KARAKTERISASI GEN TERPAUT DEFISIENSI FOSFOR PADA KELAPA SAWIT (*Elaeis guineensis* Jacq.)

Sigit Dwi Maryanto
22/502144/SBI/00214

INTISARI

Kelapa sawit (*Elaeis guineensis* Jacq.) merupakan komoditas utama penopang pertumbuhan ekonomi Indonesia. Efisiensi pemupukan dapat mendukung keberlanjutan perkebunan kelapa sawit. Fosfor berperan penting pada pertumbuhan dan perkembangan tanaman. Pada studi pendahuluan telah diperoleh dua kandidat marka molekuler terkait efisiensi P yaitu gen *EgPti1* dan *EgPap3*. Tujuan penelitian ini yaitu mengevaluasi level ekspresi gen *EgPti1* dan *EgPap3*, mempelajari aktivitas enzim yang dikontrol oleh kedua kandidat gen yaitu *APase* dan *serin/treonin kinase*, mempelajari keterpautan antara genotipe dengan fenotipe, dan mempelajari pola pewarisan sifat Mendel kelapa sawit fase *main nursery* pada alel berbeda dengan variasi dosis fosfor. Penelitian menggunakan dua material tanam yaitu klonal genotipe Prolifik dan non-Prolifik, serta bibit DxP hasil persilangan Tetua Dura dan Pisifera heterozigot yang diseleksi berdasarkan SNP kedua gen target. Bibit DxP hasil persilangan dilakukan *genotyping* menggunakan metode *Unlabeled Probe High-Resolution Melting (UP-HRM)* untuk SNP gen *EgPti1*, sedangkan metode *Cleavage Amplified Polymorphism Sequence (CAPS)* untuk SNP gen *EgPap3* kemudian dilakukan analisis Chi-square untuk mengetahui pola pewarisan Mendel. Progeni dengan alel berbeda diperlakukan variasi dosis P menggunakan media hidroponik kultur air. Evaluasi level ekspresi gen *EgPti1* dan *EgPap3* pada alel berbeda menggunakan pendekatan *Real Time Quantitative Polymerase Chain Reaction (RT-qPCR)*, analisis aktivitas enzim yang dikontrol oleh kedua gen target dilakukan analisis menggunakan metode spektrofotometri dan Dot-Blot, analisis asosiasi antara genotipe dan fenotipe menggunakan metode *principal component analysis* (PCA). Hasil penelitian yaitu a) ekspresi gen *EgPti1* dan *EgPap3* meningkat pada akar dan daun genotipe prolifik tanaman klonal; sedangkan ekspresi gen *EgPti1* dan *EgPap3* meningkat hanya pada akar pada genotipe prolifik tanaman hasil persilangan DxP; b) Aktivitas *APase* dan *serin/treonin kinase* meningkat pada akar dan daun tanaman klonal pada kondisi kekurangan P; aktivitas *APase* terjadi kenaikan pada akar dan meningkat signifikan pada daun, serta aktivitas *serin/treonin kinase* meningkat signifikan pada akar dan daun tanaman hasil persilangan persilangan DxP; c) genotipe menunjukkan keterpautan dengan fenotipe yang diperoleh, yaitu genotipe prolifik berkelompok secara terpisah dengan genotipe netral dan non-prolifik; d) pola pewarisan kedua gen dari persilangan DxP diketahui terjadi penyimpangan rasio harapan nyata dari Hukum Mendel. Hasil penelitian ini memperoleh marka molekuler yang dapat diaplikasikan untuk seleksi kelapa sawit efisiensi penyerapan P.

Kata Kunci: *EgPap3*, *EgPti1*, ekspresi gen, fosfor, hidroponik, kelapa sawit, SNP

IDENTIFICATION AND CHARACTERIZATION OF GENES ASSOCIATED WITH PHOSPHORUS DEFICIENCY IN OIL PALM (*Elaeis guineensis* Jacq.)

Sigit Dwi Maryanto
22/502144/SBI/00214

Abstract

Oil palm (*Elaeis guineensis* Jacq.) is a key commodity contributing to Indonesia's economic growth, where improving fertilization efficiency is essential for sustainable production. Phosphorus (P) is a critical nutrient influencing plant growth and development, yet its availability is often limited in tropical soils. This study aimed to evaluate the potential of two candidate genes, *EgPti1* and *EgPap3*, as molecular markers associated with P efficiency. Specifically, gene expression levels, enzyme activities (*acid phosphatase/APase* and *serine/threonine kinase*), genotype–phenotype associations, and inheritance patterns were investigated under varying P conditions. Two types of planting materials were used: clonal oil palm (Prolific and non-Prolific genotypes) and DxP seedlings derived from crosses between heterozygous Dura and Pisifera parents selected based on single nucleotide polymorphisms (SNPs) in the target genes. Genotyping was conducted using *Unlabeled Probe High-Resolution Melting* (UP-HRM) for SNP located on *EgPti1* gene; and *Cleaved Amplified Polymorphic Sequence* (CAPS) for SNP located on *EgPap3* gene, followed by *Chi-square* analysis to assess Mendelian segregation. Seedlings with different alleles were grown under hydroponic conditions with varying P levels. Gene expression was quantified using RT-qPCR, enzyme activities were measured via spectrophotometry and Dot-Blot assays, and genotype–phenotype associations were analyzed using principal component analysis (PCA). The results showed that expression of *EgPti1* and *EgPap3* increased in both roots and leaves of Prolific clonal genotypes, whereas in DxP seedlings, increased expression was observed only in roots. Under P-deficient conditions, *APase* and *serine/threonine kinase* activities increased in both tissues of clonal plants, while in DxP seedlings, *APase* activity increased in roots and significantly in leaves, and *serine/threonine kinase* activity increased significantly in both organs. PCA revealed clear separation of prolific, neutral and non-prolific groups, indicating a strong genotype–phenotype association. However, segregation of both genes in DxP deviated from expected Mendelian ratios. These findings suggest that *EgPti1* and *EgPap3* are promising molecular markers for improving phosphorus uptake efficiency in oil palm, supporting the development of more sustainable fertilization strategies.

Key words: *EgPap3*, *EgPti1*, gene expression, hydroponic, oil palm, phosphorus, SNP