Hyperspectral spectroscopy and imbalance data approaches for classification of oil palm's macronutrients observed from frond 9 and 17

ABSTRACT

This paper highlights the application of hyperspectral sensing in conjunction with imbalance approaches and machine learning (ML) algorithms to monitor the nutrients status of mature oil palm. As an alternative to the traditional foliar analysis, hyperspectral spectroscopy have portrayed a promising direction in appraising nutrients status of oil palm since the former approach is expensive, time-consuming and labour-intensive for the vast area of oil palm plantations. The aims of this study were to i) identify the spectral features that characterized leaf calcium (Ca), potassium (K), magnesium (Mg), nitrogen (N) and phosphorus (P) sufficiency levels of mature oil palm as affected by N fertilizer and ii) examine the performance of ML classifiers (Logistic Model Tree (LMT) and Naïve Bayes (NB)), as well as imbalance approaches (Synthetic Minority Over-Sampling TEchnique (SMOTE), Adaptive Boosting (AdaBoost) and combination of SMOTE and Ada-Boost (SMOTE+AdaBoost)) in classifying the Ca, K, Mg, N and P sufficiency levels from different frond numbers using the spectral features obtained in objective i. N fertilizers ranging from 0 to 6 kg N palm−1 were applied to the mature Tenera palm stands (12 and 15 years old) for three consecutive years. Spectral regions relevant to the classification of Ca, Mg and N status were the visible (Vis), near-infrared (NIR) and shortwave infrared (SWIR) while NIR and SWIR and Vis and SWIR were essential for P and K. The best discrimination of Ca, K, Mg, N and P sufficiency levels was via the LMT-SMOTE+AdaBoost model with balance accuracies (AccBalance) ranging from 76.13 to 100.00%. In general, the AccBalance of the nutrients tended to decrease as frond gets older. In summary, for assessment of oil palm nutrient status via remote sensing platforms, frond 9 was more appropriate than frond 17.

Keyword: Macronutrient; Oil palm; Frond number; Hyperspectral