ARTIFICIAL NEURAL NETWORK TECHNIQUES TO PREDICT ORANGE SPOTTING DISEASE IN OIL PALM

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ABSTRACT

In this study, different portable sensors were used to measure spectral reflectance and chlorophyll content of orange-spotted oil palm foliage. Spectral reflectance data and chlorophyll content were obtained from the leaves of healthy (non-infected), mildly infected, moderately-infected and severely-infected oil palm trees. Artificial neural network (ANN) was used to predict orange spotting disease severity. A multilayer feed-forward neural network trained with an error propagation algorithm was applied. Two training algorithms belonging to two classes have been evaluated: gradient descent algorithm, and Levenberg–Marquardt algorithm. Different ANN architectures, with various hidden neurons were examined for each training algorithm. The network trained with the quick propagation algorithm (QP) showed the best overall predictive ability.

Keywords: Precision agriculture, orange spotting disease, spectral reflectance, chlorophyll content, neural network

INTRODUCTION

Large scale oil palm plantations require timely detection of disease symptoms to enable effective intervention. Orange spotting (OS) is an emerging disease, caused by *Coconut cadang-cadang viroid* (CCCVd), that significantly reduces oil palm productivity (Hanold and Randles, 1991). Remote sensing technology offers the means to detect crop biophysical properties, including crop stress, in a cost effective and non destructive manner (Liaghat and Balasundram, 2010). The aim of this work is to obtain an optimized ANN for predicting the orange spotting disease severity through a proper selection of the training algorithm.

MATERIALS AND METHODS

The SPAD and CM1000 leaf sensor measurements were collected from the leaves of healthy (non-infected), mildly infected, moderately-infected and severely-infected oil palm trees (Shafri et al., 2009). Leaves were collected from fronds number 3, 10 and 20 of each tree. Spectral reflectance measurements were done on the same leaves by the 5-band spectroradiometer Reflectance measurements were used to calculate different vegetation indices such as NDVI, SR, MTVI1, MTVI2, G, TVI, RDVI, MCARI and SIPI. These measurements were used to make different input layers in ANN to predict the severity of OS in oil palms. The experimental data were randomly divided into two sets: 24 of data sets were used as training data and 5 of data sets were used as testing data.

RESULTS AND DISCUSSION

The Quick Propagation (QP) and Levenberg-Marquardt (LM) algorithm were used to train the neural networks. The results show that a network with 14 and 19 hidden neurons produced the best performances when LM and QP algorithm were used, respectively. Comparison between R^2 and RMSE acquired from two algorithm shows that a network with 19 hidden neurons produced the best performances when QP algorithm was employed.

CONCLUSIONS

An artificial Neural Network (ANN) was used to predict orange spotting disease severity. A multilayer feed-forward neural network trained with an error propagation algorithm was applied in this study. Two training algorithms, namely quick propagation algorithm and Levenberg–Marquardt algorithm, have been evaluated. Different ANN architectures, with various hidden neurons were examined for each training algorithm. The results of this study show that the quick propagation algorithm gave the best performances. The optimal configuration of the ANN model using quick propagation algorithm was found to be 13-19-1.

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