Using satellite-measured relative humidity for prediction of Metisa plana's population in oil palm plantations: a comparative assessment of regression and artificial neural network models

ABSTRACT

Metisa plana (Walker) is a leaf defoliating pest that is able to cause staggering economical losses to oil palm cultivation. Considering the economic devastation that the pest could bring, an early warning system to predict its outbreak is crucial. The state of art of satellite technologies are now able to derive environmental factors such as relative humidity (RH) that may influence pest population's fluctuations in rapid, harmless, and cost-effective manners. This study examined the relationship between the presence of Metisa plana at different time lags and remote sensing (RS) derived RH by using statistical and machine learning approaches. Metisa plana census data of cumulated larvae instar 1, 2, 3, and 4 were collected biweekly in 2014 and 2015 in an oil palm plantation in Muadzam Shah, Pahang, Malaysia. Relative humidity values derived from Moderate Resolution Imaging Spectroradiometer (MODIS) satellite images were apportioned to 6 time lags; 1 week (T1), 2 weeks (T2), 3 week (T3), 4 weeks (T4), 5 week (T5) and 6 weeks (T6) and paired with the respective census data. Pearson's correlation was carried out to analyse the relationship between Metisa plana and RH at different time lags. Regression analyses and artificial neural network (ANN) were also conducted to develop the best prediction model of Metisa plana's outbreak. The results showed relatively high correlations, positively or negatively, between the presences of Metisa plana with RH ranging from 0.46 to 0.99. ANN was found to be superior to regression models with the adjusted coefficient of determination (R2) between the actual and predicted Metisa plana values ranging from 0.06 to 0.57 versus 0.00 to 0.05. The analysis on the best time lags illustrated that the multiple time lags were more influential on the Metisa plana population than the individual time lags. The best Metisa plana prediction model was derived from T1, T2 and T3 multiple time lags modelled using the ANN algorithm with R2 value of 0.57, errors below 1.14 and accuracies above 93%. Based on the result of this study, the elucidation of Metisa plana's landscape ecology was possible with the utilization of RH as the predictor variable in consideration of the time lag effects of RH on the pest's population.