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Investigation of an Artificial Neural Network Model Performance in Predicting Ground Sprayer Application Characteristics

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Abstract: The performance of an Artificial Neural Network (ANN) model in predicting liquid spray application characteristics (coverage density percentage and distribution uniformity) was investigated. This was conducted to explore the potential of implementing the ANN model into the operation management of a ground field sprayer for optimum liquid agrochemical application. Data sets collected from actual field experiments were used for the purpose of training and testing the proposed ANN model. In field study, different combinations of application rate values (ranging from 172.3 L/ha to 493.3 L/h) and boom heights (ranging from 15 cm to 60 cm) were assessed based on the two calculated characteristics of coverage density percentage and distribution uniformity. The same combinations were utilized to serve as inputs to the implemented ANN model. However, coverage density percentage and distribution uniformity, represented by different values of coefficient of variation (CV), were the output (predicted) values produced by the ANN model. For the test data, ANN model predicted values were compared to the calculated values of the two spray application characteristics. For the coverage density percentage, the comparison between the predicted and calculated values showed that, during testing process, the values of the Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and coefficient of determination (R^2) were 1.192%, 1.079% and 0.991, respectively. For the CV, however, RMSE, MAE and R^2 values during testing process were 3.231%, 2.018% and 0.952, respectively. These results revealed that the proposed ANN model was accurate in estimating the values of the two spray application characteristics and can be effectively used as a management tool for optimum liquid agrochemical application out of a ground sprayer. Assuming constant nozzle flow rate and boom height, the proposed model was used to predict the CV and coverage density percentage at different application rates, represented by different ground speed values, calculated at three values of nozzle spacing (50 cm, 60 cm and 70 cm). For 50 cm, 60 cm and 70 cm nozzle spacing, the R^2 values of the polynomial relationship between ground speed and predicted CV were 0.69, 0.76 and 0.57, respectively. For the polynomial relationship between ground speed and predicted coverage density, the R^2 values were 0.96, 0.96 and 0.89 at 50 cm, 60 cm and 70 cm nozzle spacing, respectively. The neural network software was used to determine the relative importance of input variables upon predicted CV and coverage density percentage. The boom height was found to be the major variable that caused the biggest effect on the CV with 82.14% contribution. Meanwhile, the application rate was found to be the main variable affecting the coverage density percentage with 75.63 % contribution.

Key words: Artificial neural networks, ground field sprayer, distribution uniformity, coverage density percentage, application characteristics, prediction, agrochemicals.

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