Supplementary materials-Drones 1942298

Figure S1. Plots of CARS variable selection for the sensitive characteristics of nitrogen content in winter wheat plant based on the three resolution image features.
Figure S2. Transferring nitrogen prediction models constructed with 0.01 m resolution image features to 0.02 m (a) and 0.05 m (b) resolutions.
Figure S3. Transferring nitrogen prediction models constructed with 0.05 m resolution image features to 0.01 m (a) and 0.02 m (b) resolutions.

For the 0.01m resolution dataset (Figure S1A), the minimum RMSECV value was 2.26 at the 21th iteration, and a total of 15 sensitive features were finally selected, including G, R, Rededge, Nir, NDVI, RERDVI, OSAVI, con_B, con_R, sm_B, var_Rededge, var_Nir, mean_G, mean_Redege, cor_G.

For the 0.02m resolution dataset (Figure S1B), the minimum RMSECV value was 3.67 at the 18th iteration, and a total of 15 sensitive features were finally selected, including NDVI, RDVI, RERDVI, con_B, con_R, sm_B, sm_Rededge, sm_Nir, var_G, var_Nir, mean_R, mean_Redege, mean_Nir, dis_B, dis_G.

For the 0.05m resolution dataset (Figure S1C), the minimum RMSECV value was 3.12 at the 19th iteration, and a total of 15 sensitive features were finally selected, including G, R, Rededge, Nir, NDVI, RERDVI, GBNDVI, con_B, sm_B, var_Nir, mean_B, mean_G, mean_Redege, mean_ Nir, dis_Nir, hom_B.

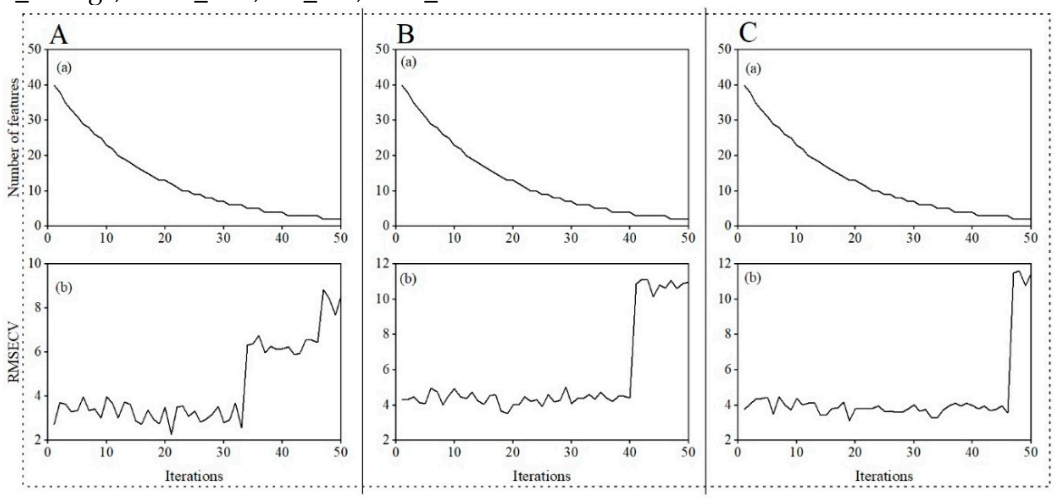

Figure S1. Plots of CARS variable selection for the sensitive characteristics of nitrogen content in winter wheat plant based on the three resolution image features. A: 0.01 m; B: 0.02 m; C: 0.05 m. (a) The number of selected plant nitrogen content sensitive features changed as the number of iterations; (b) The RMSECV values changed as the number of iterations

To further elucidate the transferability of models with different resolutions, a model was firstly developed from the 0.01 m dataset only using sensitive features selected with the CARS method and then applied to 0.02 m and 0.05 m images with their corresponding sensitive features to evaluate the transferability. The scatterplots between the measured and predicted values are shown in Figure SF2. The model constructed by 0.01 m resolution image features predicted the nitrogen content with R^2, RMSE, MAE, and RPD were 0.84, 4.70 g m^{-2}, 3.17 g m^{-2}, and 2.38, respectively, at 0.02 m resolution; and the prediction results at 0.05 m resolution with R^2, RMSE, MAE and RPD were 0.89, 3.68 g m^{-2}, 2.87 g m^{-2}, and 2.94, respectively. This result (shown below) is in agreement with the transferability of the model (section 3.5 of the original manuscript) constructed using the same set of sensitive features for all three-resolution datasets.

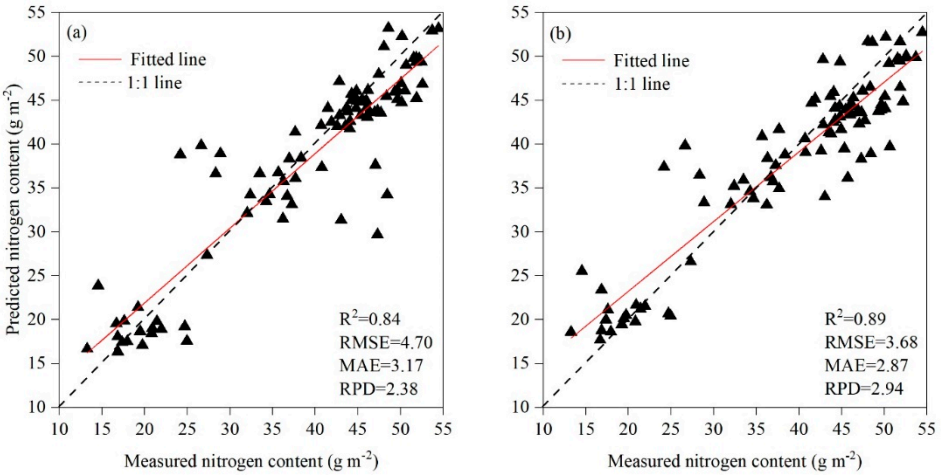

Figure S2. Transferring nitrogen prediction models constructed with 0.01 m resolution image features to 0.02 m (a) and 0.05 m (b) resolutions.

Similarly, the model was developed using the sensitive features selected from the 0.05m dataset only with the CARS method and applied to 0.01m and 0.02m images with their corresponding sensitive features to evaluate the model transferability (Figure SF3). The model predicted the nitrogen content with R^2, RMSE, MAE and RPD of 0.86, 4.27 g m^{-2}, 2.58 g m^{-2} and 2.73, respectively, at 0.01 m resolution and of 0.83, 4.82 g m^{-2}, 2.90 g m^{-2} and 2.34, respectively, at 0.02 m. Because the model established with the 0.05 m images only had a slightly better performance than the transferred models, with R^2, RMSE, MAE, and RPD of 0.92, 3.17 g m^{-2}, 2.45 g m^{-2}, and 2.86 (Figure 4c), respectively, this indicates that the model constructed with 0.05 m resolution image features also has a reasonably good transferability in the downscaling case. Similarly, this result is also in agreement with the transferability of the model (section 3.6) constructed with sensitive features selected for all three-resolution datasets.

Therefore, whether a single resolution dataset or multiple resolution datasets were used as CARS input, the selected image features could achieve a satisfactory prediction of plant nitrogen content. It can be concluded that all the UAV images acquired in this study with different resolutions could achieve good predictions and transferability of the nitrogen content of winter wheat plants.

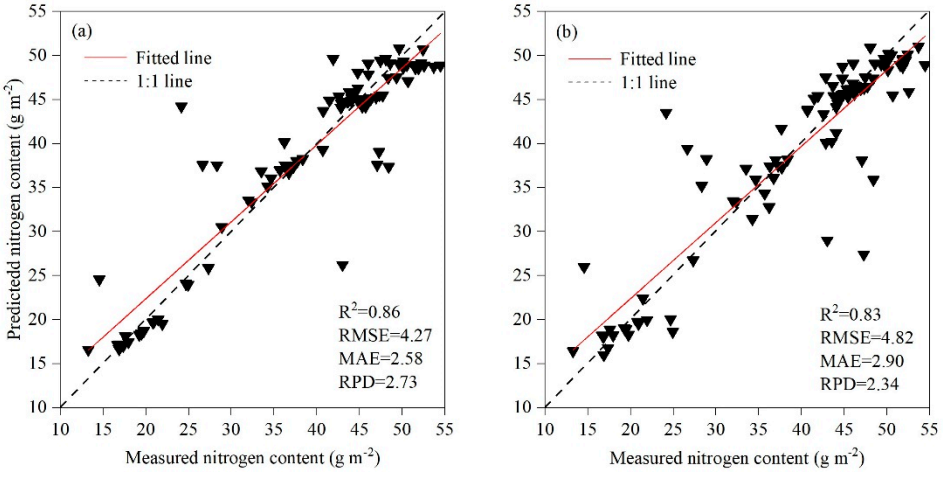

Figure S3. Transferring nitrogen prediction models constructed with 0.05 m resolution image features to 0.01 m (a) and 0.02 m (b) resolutions.