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Winter wheat yield estimation of remote sensing research based on WOFOST crop model and leaf area index assimilation

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Accurate crop growth monitoring and yield predictive information are significant to improve the sustainable development of agriculture and ensure the security of national food. Remote sensing observation and crop growth simulation models are two new technologies, which have highly potential applications in crop growth monitoring and yield forecasting in recent years. However, both of them have limitations in mechanism or regional application respectively. Remote sensing information can not reveal crop growth and development, inner mechanism of yield formation and the affection of environmental meteorological conditions. Crop growth simulation models have difficulties in obtaining data and parameterization from single-point to regional application. In order to make good use of the advantages of these two technologies, the coupling technique of remote sensing information and crop growth simulation models has been studied. Filtering and optimizing model parameters are key to yield estimation by remote sensing and crop model based on regional crop assimilation.
Winter wheat of GaoCheng was selected as the experiment object in this paper. And then the essential data was collected, such as biochemical data and farmland environmental data and meteorological data about several critical growing periods. Meanwhile, the image of environmental mitigation small satellite HJ-CCD was obtained.
In this paper, research work and major conclusions are as follows.
(1) Seven vegetation indexes were selected to retrieve LAI, and then linear regression model was built up between each of these indexes and the measured LAI. The result shows that the accuracy of EVI model was the highest (R2=0.964 at anthesis stage and R2=0.920 at filling stage). Thus, EVI as the most optimal vegetation index to predict LAI in this paper.
(2) EFAST method was adopted in this paper to conduct the sensitive analysis to the 26 initial parameters of the WOFOST model and then a sensitivity index was constructed to evaluate the influence of each parameter mentioned above on the winter wheat yield formation. Finally, six parameters that sensitivity index more than 0.1 as sensitivity factors were chose, which are TSUM1, SLATB1, SLATB2, SPAN, EFFTB3 and TMPF4. To other parameters, we confirmed them via practical measurement and calculation, available literature or WOFOST default. Eventually, we completed the regulation of WOFOST parameters.
(3) Look-up table algorithm was used to realize single-point yield estimation through the assimilation of the WOFOST model and the retrieval LAI. This simulation achieved a high accuracy which perfectly meet the purpose of assimilation (R2=0.941 and RMSE=194.58kg/hm2). In this paper, the optimum value of sensitivity parameters were confirmed and the estimation of single-point yield were finished.

Key words: yield estimation of winter wheat, LAI, WOFOST crop growth model, assimilation