EXTRACTING SPATIAL INFORMATION OF HARVEST INDEX FOR WINTER WHEAT BASED ON MODIS NDVI IN NORTH CHINA

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Abstract: Harvest Index (HI) of crop is one of the most important factors affecting the crop yield. Many researches had been done on it to increase crop yield by agronomist and agronomy breeding expert. Generally speaking, HI of one crop has certain stability in a small region for a period of time and has a better positive relationship with its yield. These relationships have been widely used in crop simulation and yield prediction using remote sensing data. Under many situations, HI parameter is regarded as a constant through referring to published literatures or getting from field observations results. But in a larger region, there is a certain variance for different varieties of a same kind of crop. There is no doubt that regarding HI as a constant in a larger region is not reasonable and can't meet the need of accuracy of crop simulation and yield prediction. So getting the spatial information of crop harvest index early is meaningful to improve accuracy of crop simulation and yield estimation.

In this paper, the authors attempted to develop a new method to extract the winter wheat harvest index information depending on the 250m 10-day EOS/MODIS NDVI data. The process was below as follows:

(1) two new parameters were structured after analyzing the crop growth profile which is the curve of time series of NDVI and time and that the parameters can indirectly reflect the meaning of HI. The two parameters are HI_{NDVI_SUM} and HI_{NDVI_k}.

$$HI_{NDVI\_SUM} = \frac{\sum NDVI_{post}}{\sum NDVI_{pre}}$$

$$HI_{NDVI\_k} = -\frac{\overline{k}_{post\_descend}}{\overline{k}_{pre\_ascend}}$$

Where $\sum NDVI_{post}$ is the accumulative total 10-day MVC NDVI after maximum and

reflect dry matter accumulation of grain; $\sum NDVI_{pre}$ is the accumulative total 10-day MVC NDVI before maximum and reflect dry matter accumulation of stem and leaves; $\overline{k}_{post\_descend}$ is mean descend speed of NDVI from the stage of anthesis to the stage of mature and reflect the growth condition of grain filling; $\overline{k}_{pre\_ascend}$ is mean ascend speed of NDVI from the stage of reviving to the stage of anthesis and reflect the growth condition of stem and leaves from the reviving stage to the anthesis stage; the parameters such as $\sum NDVI_{post} / \sum NDVI_{pre}$ and $\overline{k}_{post\_descend} / \overline{k}_{pre\_ascend}$ indirectly reflect the meaning of definition of HI which is the ratio of seed mass to total above-ground plant mass. The negative sign was to change the value of $\overline{k}_{post\_descend} / \overline{k}_{pre\_ascend}$ from negative to a positive number by force.

(2) relationships were established between the two parameters and the relevant field measured HI at the same point.

(3) using the new parameter derived from the update 10-day NDVI data to predict the HI spatial information and validation was done through comparing the predicted HI with the measured HI in the field.

(4) analyzing the accuracy of each parameter to predict the HI and confirming the better parameter for extracting the HI spatial information.

Finally, we selected the Hengshui City (including 11 counties) as our study region which is important main crop producing region in Huanghuaihai Plain in China. Field measured points were distributed symmetrically in each county. In order to improve the quality of 10-day MVC MODIS-NDVI, especially to eliminate the cloud-contaminated data and abnormal data in the MODIS-NDVI series, the Savitzky-Golay filter was applied to smooth the 10-day NDVI data. The field measured HI data of the year 2004 and 2007 including 71 field survey points were used to establish the relationships between the two new parameters and measured HI. The field measured HI of the year of 2008 including 46 field survey points were used to validate the accuracy of the predicted spatial HI information. At last, the mean relative error of predicted HI of the two parameters HI_{NDVI_k} and HI_{NDVI_SUM} was 3.60% and 2.40% respectively. The corresponding RMSE of predicted HI of the two parameters was

0.04 and 0.02 respectively. We thought HI_{NDVI_SUM} was more effective to predict HI than the parameter HI_{NDVI_k} although the two parameters both could get good spatial HI information at regional level.

Key words: harvest index; crop; winter wheat; remote sensing; MODIS; NDVI; Savitzky-Golay filter