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基于冠层光谱植被指数的冬小麦作物系数估算

Estimating crop coefficients of winter wheat based on canopy spectral vegetation indices

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中文摘要:

目前针对局地气候条件下某一作物类型的作物系数及其年际变化已开展了较多分析，但适于区域尺度运用的作物系数估算方法的研究还比较缺乏，这是将FAO 56作物系数法成功应用于区域作物实际蒸散量估算的关键环节。该文基于2008－2009和2009－2010年度2个冬小麦生长季的大田试验数据，研究了作物系数（Kc）、基本作物系数（Kcb）与8种常用冠层光谱植被指数（VIs）的相关关系以及水分和氮素胁迫对其的影响，分析了基于VIs估算作物Kc、Kcb的可行性，并对其估算精度进行了验证。结果表明，高氮水平下Kcb较大而土壤蒸发系数（Ke）较小，低氮水平下Kcb较小而Ke较大，不同施氮水平下Kc无明显规律性差异。冬小麦Kc与VIs相关性较弱（决定系数R2＝0.094～0.150，p<0.01，n＝195），而Kcb与VIs则具有很强的相关性（决定系数R2＝0.511～0.685，p<0.01，n＝195）；施氮水平不影响Kcb－VIs关系，而不足以使冠层光谱出现明显表征的水分胁迫可使Kcb－VIs相关关系减弱。利用VIs估算的冬小麦实际生长条件下的Kcb值与FAO 56确定的Kcb值均具有很好的线性回归关系（R2＝0.765～0.864，n＝150），其中增强型植被指数（EVI）的估算精度最好。但在不足以使冠层光谱出现明显表征的水分胁迫条件下，利用该法可能会产生较大误差，还需要结合其他途径获取的水分胁迫信息来准确确定。

英文摘要:

Abstract: At present, many studies have been carried out on crop coefficients and its variation over years under local climate conditions, but little attention has been given to its estimation method for a regional scale, which plays a key role in the regional application of the FAO 56 crop coefficient approach in crop evapotranspiration and transpiration estimation. In this work, experiments including five nitrogen (N) treatments were conducted in the 2008-2009 and 2009-2010 seasons to investigate the relationships between the crop coefficient (Kc), basal crop coefficient (Kcb) and eight common canopy vegetation indices (VIs) of winter wheat, as well as the effects of N and water stress on them. In addition, the feasibility and the performances of VIs on Kc and Kcb estimation of winter wheat were analyzed. Results demonstrated that high levels of N were associated with high Kcb and low Ke, and vice versa, which resulted in no obvious regular differences in Kc among different N treatments. Crop Kc was weakly correlated with VIs (the coefficient of determination R2 = 0.094 ~ 0.150, p < 0.01, n=195) due to the variations in soil evaporation and soil background, while Kcb had strong correlations with VIs (R2 = 0.511 ~ 0.685, p < 0.01, n=195). In addition, the water stress before resulting in an obvious sign on crop canopy spectral characteristics can introduce considerable scatter in the relations between Kcb and VIs, while N stress had no effects on them. Validation results showed that VIs performed well in crop Kcb estimation, and the enhanced vegetation index (EVI) gave the best accuracy (R2 = 0.765 ~ 0.864, n=150). The proposed method would be more favorable for regional application, since VIs can be easily collected by means of remote sensing. However, it should be pointed out that the method may have some limitations under the conditions with water stress but is not severe according to the above analysis, and as in this case, additional water stress information collected from other sources like thermal images and ground-based wireless sensor network observation would be needed.

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