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涝渍胁迫条件下**Morgan**模型的试验研究

Experimental study on Morgan model under waterlogging stress

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中文摘要:

涝渍胁迫条件下的作物水分生产函数对于正确评估减灾效益，合理制定涝渍灾害治理对策具有重要现实意义。作物水分生产函数按照模型形式可分为动态模型与静态模型，其中动态模型能模拟作物生长过程，具备一定的作物生理学基础，但鲜有见到关于涝渍胁迫条件下动态模型的研究。该文以水分亏缺条件下的作物水分生产函数动态模型（Morgan模型）为基础，通过利用涝渍指标进行转换，建立了适用于涝渍胁迫条件下的动态产量模型。该模型选用的指标包括常用的空间划分型涝渍分离指标（累积超标准地下水深SEW30、地面累积淹水深度SFW）与涝渍综合指标SFEW30，并为了克服前者在计算过程中涝害指标权重偏小的问题，引入时间划分型涝渍分离指标（累积超标准地下水深SEW30、受涝期间涝渍综合指标SWFDH）。根据连续多年的棉花涝渍胁迫试验数据对模型进行参数率定与验证，结果表明该模型预测效果良好，并推荐优先使用涝渍综合指标SFEW30。同静态模型相比，该模型参数在年际之间也表现出更好的稳定性。

英文摘要:

Abstract: The crop water production function under waterlogging stress is of significance both for the benefit evaluation of disaster reduction and the decision making of waterlogging disaster control. Crop water production functions can be categorized into two kinds: dynamic model and static model. Since the dynamic models were based on a certain crop physiology basis, it can be used to simulate the process of crop growth. However, the dynamic models under waterlogging were rarely found in publications. Based on the Morgan model, which was originally used for crop yield simulation under water deficit, this paper established a revised Morgan model for waterlogging stress by replacing the soil moisture index with waterlogging indexes. The waterlogging indexes widely used in practice were subsurface-surface separated index (SEW30, SFW) and composite index SFEW30. But the former had a problem that the weight of surface waterlogging index was too small compared with subsurface waterlogging index. To balance the weight of subsurface and surface waterlogging indexes, the separated indexes were divided by time such as (SEW30, SWFDH) and space such as (SEW30, SFW) respectively. All the three different waterlogging indexes i.e. (SEW30, SFW), (SEW30, SWFDH), SFEW30 were used to revise the Morgan model in order to obtain the most suitable index. Waterlogging experiments on cotton were carried out in 22 lysimeters at Irrigation and Drainage Comprehensive Experimental Station in Wuhan University from 2008 to 2011. Dry matter yield samples were taken every 10 days, and the dynamic change of groundwater table was monitored every day during the period of waterlogging. Data in 2009 and 2010 were used to calibrate parameters and the data in 2008 and 2011 were used to validate the revised Morgan model. Results showed that the cotton dry matter yields predicted by the revised Morgan model adopting three different indexes all coincided with the observed yields well, especially the indexes (SEW30, SFW) and (SFEW30). The corresponding revised Morgan model adopting the two indexes both achieved a high significance level of 0.001 in both 2008 and 2011 with a smaller relative error of less than 20%, which showed that, the revised Morgan model was effective and practicable for cotton dry matter yields simulation under waterlogging stress. Considering the less amount of parameters in model and precision, the composite index (SFEW30) was recommended to adopt in the revised Morgan model preferentially, but only by adopting the index (SEW30，SFW), the effect of subsurface and surface waterlogging on dry matter yields can be analyzed respectively. In order to make a comparison between the revised Morgan model and the static model, both of them were calibrated and validated with the same data obtained from the waterlogging experiments, and the simulated yields of both of the two models were compared with the observed yields. Results showed that the prediction of the revised Morgan model both an acceptable significant level of 0.05 in 2011 and a relative small relative error of less than 20% in 2008 while the static model failed to achieve these error indexes, which indicated that the revised Morgan model had a better stability than the static model in different years.