郭相平,甄 博,王振昌.旱涝交替胁迫增强水稻抗倒伏性能[J].农业工程学报,2013,29(12):130-135

旱涝交替胁迫增强水稻抗倒伏性能

Increasing lodging resistance performance of rice by alternating drought and flooding stress

投稿时间： 2012-12-06 最后修改时间： 2013-05-16

中文关键词: 力学特性,试验,生长,水稻,旱涝交替胁迫,倒伏,细观结构

英文关键词:mechanical properties experiments growth rice alternate drought and flooding stress lodging mesostructure

基金项目:水稻旱涝交替胁迫叠加效应及其机理研究（51079042）及江苏省"青蓝工程"资助项目。

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中文摘要:

茎倒伏是水稻减产的重要影响因素。本文采用小区试验，分析了旱涝交替胁迫下旱后浅蓄（T1）、旱后深蓄（T2）与目前常用的浅水勤灌（CK，对照）模式下，水稻茎秆生长指标和抗倒伏指标的差异，并结合水稻茎秆的细观特征，对水稻抗倒伏能力的影响机制进行了探讨。结果表明，与对照相比，适宜的旱涝交替胁迫处理（T1）基部节间长度降低，茎粗、茎杆截面面积增加，但差异不显著；茎杆的抗弯截面模量和累积破坏能量分别增加12.4%和9.4%，差异达到显著水平；茎杆壁厚、维管束数量、维管束面积增加，维管束细胞趋于密实，使得茎杆的抗折力增加，倒伏指数下降。但旱后淹水深度过深（T2），水稻抗倒伏指标下降。地上部分鲜重增加是T2处理倒伏指数增加的主要原因。上述情况表明，适宜的干旱胁迫能够拮抗淹水胁迫造成的抗倒伏能力下降，提高后期抗倒伏能力。现有节水模式下适当加大雨后蓄水深度不会增加倒伏风险。

英文摘要:

Abstract: Stem lodging could result in the reduction of rice yield and was easily affected by drought and flooding which were widely used to reduce irrigation water applied by reducing evaportanspiration and catching rainwater. Previous studies found that flooding could decrease the ability of resistance lodging in most cases while drought has the opposite effects. So it seems possible to mitigate the negative effects of flooding by using the advantages induced by drought under rain-catching and controlled irrigation mode. However, how alternate drought and flooding stress affect the ability of resistance lodging, as well as its underlying mechanism for these behaviors has remained elusive. In this study, three field experiments of T1 (slight drought combined with shallow depth of water after rainfall in paddy field), T2 (slight drought combined with deep depth of water after rainfall in paddy field) and CK (conventional irrigation mode for rice which always keep the shallow depth of water in paddy field) , were established to investigate the responses of stem anatomical structure, stem growth indexes and lodging resistance capabilities to the alternate drought and flooding stress as well as to illustrate the lodging resistance mechanisms for rice stalks under rain-catching and controlled irrigation mode. The results indicated that compared with CK, T1 could decrease the basal inter-node length and increase the stem diameters and stem cross section areas, even thought the differences were not significant. Compared with CK, T1 significantly increased the bending cross-section modulus and cumulative damage energy of stems by 12.4% and 9.4%, respectively; according to stem mesostructure of different treatments, the increase of stem wall thickness, vascular bundles numbers and vascular areas together with the compact vascular cells finally resulted in the improvement of the fracture resistance and the decrease of lodging resistance indexes. Whereas, because of the extremely higher depth of water levels after drought stress, the capability of lodging resistance for T2 treatment decreased. The rising or decline of fresh weight above ground was the major reason for the increase or decrease of lodging resistance indexes rather than that of fracture resistance. In conclusion, properly drought stress exposed in the late growth stage of rice could compensate the decrease of lodging resistance capability and could be used to improve the lodging resistance capability of rice stalk under alternate drought and flooding stress. It also suggested that further increasing the depth of water levels after heavy rain in paddy field under the current water-saving mode would not increase the risk of lodging for rice plant.