



Assessment of environment lodging stress for maize using fuzzy synthetic evaluation

Chunqiao Mi, Xiaodong Zhang*, Shaoming Li, Jianyu Yang, Dehai Zhu, Yang Yang

College of Information and Electrical Engineering, China Agricultural University, Beijing, 100083, PR China

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ABSTRACT

Lodging in maize, which is the result of the genotype-by-environment interactions, causes severe yield losses annually. There are many studies on lodging resistance of maize varieties now, but information about maize planting environment lodging stress is very rare. The environment lodging stress, which is a result of various factors, is characterized by uncertainty. Fuzzy sets theory and fuzzy logic are advantageous for dealing with the questions with uncertainties. The objective of this study is to assess the environment lodging stress for maize planting. Based on the daily weather data in the recent 59 years (1951–2009) and soil data, five counties (or cities) in ShanDong Province and HeNan Province in Huang-Huai-Hai-Plain, China, are selected as study sites; the maximum wind speed, rainfall, and potassium content in soil are chosen as stress indicators, and the overall stress level of each study site is obtained by a fuzzy synthetic evaluation approach. The consistency is shown between our calculation results and the results obtained with actual survey data on lodging in maize, indicating that the employed model is a promising approach for assessing environment lodging stress, and providing a scientific basis for maize variety extension and recommendation and comprehensive management to reduce maize planting risk and loss.

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1. Introduction

Lodging (root lodging and stalk lodging) in maize is one of the major problems in maize production worldwide, which accounts for annual yield losses of 5%–25% in this crop [1,2]. It has a detrimental effect on a plant's translocatory and photosynthetic activity [3]. Lodged plants are those whose stalks are completely or partially broken or lean at 30° or more from the vertical [4]. Root lodging is partial or total uprooting due to weak roots. Whilst stalk lodging is stem breakage or a consequence of stem borer attack or stalk rot occurring at or around physiological maturity [5]. Apart from decreases in yield, lodging may result in a more difficult harvest and reduction in crop quality [3,5–7]. However, by assessing the target environment lodging stress and avoiding choosing varieties susceptible to lodging for the target environment where lodging stress is severe, the risk and loss can be significantly reduced.

It is known that lodging in maize is the result of the genotype-by-environment interactions [8]. Lodging resistance in maize has been related to some of its morphological characters [9–12], such as plant height, diameter and length of basal internode, thickness of rind and weight of 5 cm basal section, stalk breaking strength, crushing strength, stalk diameter, weight and density as well as rind penetrometer resistance. Zuber and Grogan demonstrated that a good relationship exists between rind thickness, crushing strength and field stalk lodging [13]. Besides, stalk chemical constituents such as lignin, total nonstructural carbohydrates, potassium, nitrogen and sodium have been used to estimate lodging in maize [14–17].

* Corresponding address: China Agricultural University, College of Information and Electrical Engineering, P.O. BOX(698), No. 17 Tsinghua East Road, 100083 Beijing, PR China. Tel.: +86 010 62736954; fax: +86 010 62736954.

E-mail address: zhangxd@cau.edu.cn (C. Mi).