

Advances in research on tortuous traits of plants

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Abstract Tortuous-stem plants have extremely high ornamental value due to the zigzag shape or natural twisting of the branches. At present, the research about tortuous-stem plants focuses mainly on the morphological characteristics, anatomic structure and genetic characteristics, but few studies have been conducted on the genetic mechanism of tortuous stem traits. In recent years, numerous tortuous-stem mutants have been screened from *Arabidopsis thaliana*, *Zea mays*, *Glycine max*, *Lycopersicon esculentum*, *Prunus* and *Populus* indicating that tortuous traits may be closely related to the abnormal geotropic growth, uneven distribution of hormones and asymmetric

development of vascular bundles. In this paper, advances in morphological characteristics, environmental regulation, genetic patterns, molecular mechanism and application prospects of tortuous-stem plants were summarized, aiming at providing the basis for revealing the molecular mechanism of tortuous stem traits.

Keywords Tortuous traits · Phenotype · Genetic characteristics · Molecular mechanism · Research advances

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Introduction

Shoots not only play an important role in material transportation and support, but also serve as ornamental organs in plants. Ornamental plants can be classified into straight-stem, pendulous-stem and tortuous-stem types. Tortuous stems exhibit an overall upward growth trend and stem sections are naturally twisted in a zigzag pattern, resulting in a peculiar and graceful shape. Tortuous-stem plants have high ornamental value during the leaf expansion period and after defoliation (Smith and Mehlenbacher 1996). So far, tortuous-stem plants have been widely planted as excellent tree species along the roads, and in parks and residential areas because of the dynamic beauty of