Mechanical Properties and Anatomical Components of Stems of 42 Grass Species.

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Stems of grass support much of the world's food supply during grain maturation. The purpose of this study was to determine the mechanical properties of stems and to determine if thick-walled, sclerenchyma cells are the main components that resist stem bending for 42 species of grass plants. During tests, stresses were imposed on grass stem segments to more than 90% of the maximum elastic load. Anatomical analyses were also performed to determine relationships between mechanical properties and geometric/anatomical characteristics of grass stems. Data show that more than 59% of all sclerenchyma cells in stems occur in the outer one-fifth radius of stems. Although values of outer diameter, inner diameter and stem density varied by factors of 10 and values of modulus of elasticity ranged from 0.1 to 32 GPa and maximum bending moment from 0.001 to 2.9, all of these parameters showed normal distributions. Results of stress tests show that maximum bending moment was highly correlated with section modulus so that more than 90% maximum bending stress values were between 1.0 and 6.0 X 10^7 Pa among the grass species tested. These values were relatively constant with a mean of 2.0 X 10^7 Pa. Data of this study also show that maximum bending moments of the 42 species were correlated well ($y= 0.028x + 0.0001$, $r^2= 0.64$) with the areas of thick-walled sclerenchyma cells in stems. Taken together, these data show that the mechanical properties of all grasses studied were remarkably similar, maximum bending stress values of all 42 grass species were nearly identical and that sclerenchyma cells in stems provided the major support for stem integrity at the upper limit of imposed stem stresses.