ANALYSIS OF THE RELATIONSHIP BETWEEN CRYSTALLITE ORIENTATION AND FIBER STRENGTH WITHIN *GOSSYPIUM*

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Abstract

In the fiber cell wall, the super-molecular structure of cellulose, including percent crystallinity, crystalline grain size (CGS), orientation distribution angle (ODA), microfibril spiral angle (SA), and orientation separate angle (OSA), has significant influence on fiber strength. CGS reflects the average number of glucan chains forming individual cellulose crystallites. SA represents the angle between the average cellulose microfibril axis and the longitudinal fiber axis. OSA represents the angle of variance between the orientation of cellulose crystallites and the longitudinal axis of the microfibrils in which they are contained. ODA is a value calculated from OSA and SA that reflects the angle of variance between the orientation of cellulose crystallites and the longitudinal fiber axis. Using X-ray diffraction and calculation based on X-ray parameters, all of the above parameters, and their influence on fiber strength, were analyzed for 4 cultivated cotton species (*G. hirsutum, G. barbadense, G. arboreum*, and *G. herbaceum*) and some varieties of Upland cotton. Percent crystallinity and CGS did not vary between species or varieties; therefore, they had no close correlation with fiber strength. Orientation of cellulose microfibrils/crystallites had significant effects on fiber strength, but to varying degrees in different species or varieties. Among different cultivated species, OSA was most strongly correlated with strength, but for different varieties of Upland cotton, SA and ODA were the most important. From the microfibril orientation, we can obtain a formula to demonstrate or calculate the correlation between fiber 0 gauge strength and ODA or SA: $To = Tk \cos ODA = k\, T_k \cos SA$ (T_k is the theoretical maximum of 0 gauge strength when the ODA or SA is 0). Therefore, the lower the ODA or SA, the higher the fiber strength. The old cultivated cotton species (*G. arboreum* and *G. herbaceum*) had the lowest SA and ODA values, whereas *G. barbadense* has the highest fiber strength (i.e. theoretical maximum value of 0 guage strength). Therefore transferring lower SA and ODA traits could increase fiber strength of *G. hirsutum* and even *G. barbadense*. In summary, we determined that there must be factors other than fiber structure, such as extent or dynamics of cellulose deposition, that influence fiber strength.

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