Predicting cotton yield and lint quality and making appropriate management decisions during the growing season are appealing ideas for farmers, ginners, and policy decision-makers. Mechanistic cotton simulation models are needed to assist not only for farmers and ginners for management and marketing decisions, but also for scientists and policy-makers to assist natural resource management decisions. Prior attempts to predict yield, particularly fiber quality, have been limited because of difficulties in conducting meaningful experiments as fiber growth and development and plant water status are dynamic processes impacted by many environmental factors. Temperature and plant water status are the two most important stresses affecting crop production globally including cotton yield and fiber qualities.

Even though cotton is capable of exhibiting plasticity in growth to environmental stresses because of its indeterminate growth habit, it grows and produces bolls/fruits under a narrow range of temperatures. During the growing season, it is not uncommon for air temperature to be above or below the optimum temperature for fruit/boll development. In addition, cotton is not an efficient water consumer, and therefore, the duration, intensity, and developmental stage at which water stress occurs are the key for efficient production. Areas of the U.S. Cotton Belt show significant fluctuations in the temperature and rainfall event during May to October that coincides with peak growth and development of reproductive structures in cotton. Therefore, it is important to know the lint quality and quantity responses to temperature stress and water-limiting conditions.

In the May–June and July–August 2014 issues of Agronomy Journal, researchers from Mississippi State University (MSU) report studies demonstrating the sensitivity of cotton fiber quality to temperature and soil moisture deficiencies. The studies used a unique sunlit plant growth system known as the Soil–Plant–Atmosphere–Research (SPAR) facility at MSU. A genetic standard for many breeding and molecular studies of upland cotton cultivar Texas Marker (TM)-1 was used in both the studies using 1-m-deep soil bins filled with fine sand as a growing medium.

In one experiment, four day/night temperatures representing the temperature variability of current and projected future climatic conditions across U.S. Cotton Belt were varied during flowering under optimum water and nutrient conditions. In another experiment, four water stress treatments were imposed from flowering to maturity of the crop under optimum temperature conditions. Plant growth, development, and photosynthetic rates were measured regularly during the season, but more emphasis was given to reproductive performance and fiber quality parameters to develop fiber quality functional algorithms for those stresses that could help develop fiber quality models.

Along with significant differences that occurred in the reproductive development, more pronounced differences in fiber properties were of particular interest in these studies. Carbon assimilation rates were greatly affected by water and temperature stress conditions; therefore, there were significant reductions in plant biomass at low and high temperature stresses and moisture deficit conditions. Boll number and weights were substantially decreased at high temperature and at severe water deficit conditions.

Fiber parameters that are of interest to the textile industry were also altered by temperature and moisture deficit. Fiber micronaire and uniformity increased with temperature up to 26°C and declined at higher temperature, while fiber strength increased linearly with temperature. Fiber length increased linearly from 18 to 22°C and declined at higher temperatures.

Fiber micronaire was more responsive to changes in temperature followed by strength, length, and uniformity. Fiber length, strength, and uniformity were decreased with greater water deficits except for fiber micronaire. More immature fibers were produced at a moisture deficit regime, decreasing maturity ratio. Fiber strength was more responsive to changes in moisture conditions followed by micronaire, length, and uniformity.

The functional relationships between temperature and water stress with respect to fiber properties will be valuable to develop fiber quality models. Resulting improved cotton models will be useful for optimizing production decisions.

Adapted from: