Why Cotton Varieties Differ In Yield

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Significant variation in lint yield has been measured in almost all of the approximately 100 cotton variety tests that I have conducted over the past 35 years. The rare exceptions occurred in non-irrigated tests or in tests that were overwhelmed by some other factor. Lint yield can certainly be affected by soil type, many weather/climatic factors, planting date, fertilizer, etc. - but these factors should be the similar for all entries in a variety test. Experimental error can also provide false lint yield results, but should randomly affect specific varieties. In this presentation, only factors that may possibly differ between varieties within a test will be considered. These factors may include variation in:

1. Seed quality and subsequent stands – Genetic variation among varieties for seed quality is poorly defined and likely very small. Environmental differences associated with differing seed sources likely exceeds genetic variation for seed quality. Also, most variety tests are seeded at relatively high rates. Since cotton is able to tolerate wide difference, variation in stands should seldom affect yield of varieties.

2. Plant resistance to insects – Other than transgenes, variation in plant resistance to insects is relatively small. Most variety tests are scouted, and insect pests are maintained below treatment thresholds. Some cottons, particularly Bt or W varieties, may incur less sub-threshold levels of pests than conventional cottons. Variation in resistance to tarnished plant bug may all some resistant varieties to produce higher yields.

3. Plant resistance to diseases – Current seed treatments generally give all varieties adequate protection from seedling diseases. Variation in response to vascular wilts and nematodes exists among varieties, and may affect yield in tests where these pathogens occur. Little genetic variation in resistance to boll rots exist. However, extent of boll rots may differ greatly among varieties within a test due to variation in boll opening relative to insipient wet weather conditions.

4. Plant response to environmental extremes – Although the environment should be the same for all entries in a test, the ability to tolerate environmental extremes, e.g. temperature and soil water, may differ among cultivars. Unfortunately, variation in plant response to environmental extreme is not well-documented or understood.

5. Plant response to nutrients – Cotton varieties may different in their ability to take up and efficiently utilize nutrients. Again, variation in plant response to nutrients is not well-documented or understood.

6. Fruit retention – Primary causes of cotton fruit loss are insect damage (see factor #2 above) and physiological shed. Physiological shed is typically associated with stress on the plant. Stress may be good (e.g. high boll load) or bad (e.g. factor that limits plant growth). Fruit retention should be considered in relation to cause of fruit loss, relative plant size, and stage of plant development.

7. Plant structure – Plant structure may be quantified by first fruiting node (FFN), plant height, degree of vegetative branching, and plant shape. The relatively low genetic variation for these parameters may be overwhelmed by variation in plant spacing. With approximately equal plant density, variation in plant height and degree of vegetative branching is usually related to maturity of varieties. Variation in plant shape (or conformation) was once given high priority in development of varieties, but not receives little attention.

8. Maturity – Cotton varieties display distinct variation in maturity, and this difference can affect relative yields in specific environments. Differences in maturity are often related to variation in plant structure and/or early fruit retention.

9. Yield components – The most basic model of lint yield is: number of seed per acre (SPA) times weight of lint per seed – with SPA have a greater influence than lint per seed. But SPA is more affected by environment, while lint per seed (lint index) is more affected by genetics. Therefore, improvement of lint index should increase yield stability of a variety.

10. Other plant physiological factors – Cotton yields of different varieties may be influenced by qualitative and quantitative variation in a myriad of endogenous plant chemicals involved in metabolism. These plant chemicals may be involved with various enzymatic reactions, and in the operations of proteins, carbohydrates, lipids and growth regulators.

So, why do cotton varieties differ in yield within a relatively uniform testing environment? Sometimes the reason is known or suspected, but most often it is not known and/or there are several factors and interaction of factors involved. A better understanding of factors contributing to yield is valuable to cotton breeders as they make selections and to producers as they choose varieties to plant. Nevertheless, much progress has been achieved without a full understanding. All commercial varieties have produced outstanding yields in certain environments. Although testing environments differ greatly, a few varieties seem to always be among the ones that produced highest yields over a wide range of environments. Such varieties are considered to be broadly adapted and highly desired. Other varieties should not be uniformly discarded, but examined closely to determine where they might best fit.