INHERENT BIASES IN THE ARKANSAS COTTON VARIETY TESTING PROGRAM

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Abstract

Several unintentional biases are inherent to all cotton variety testing programs. The relative influence of these potential biases vary with the specific experimental methods employed. The objective of this paper is to enumerate and discuss the effects of various inherent biases that are associated with methods used in the Arkansas Cotton Variety Testing Program. The biases include factors associated with seed and stand (stand quality differences due to variation in initial seed quality), variety-specific management (inputs that may differ among varieties due to plant maturity, plant height, and insect and herbicide resistance), and sampling and ginning (effects of ginning small samples on laboratory-sized gin to determine turn-out and fiber properties). Some varietal types are given a slight advantage over other types because of the specific methods used. Overall, the biases tend to cancel each other so that any one varietal type is not given a great advantage. However, when interpreting data from the Arkansas Cotton Variety Testing Program, these potential advantages should be considered.

Introduction

The primary goal of cotton variety testing programs is to provide unbiased, fair comparisons of diverse cotton varieties. This information assists cotton producers in making planting decisions and helps seed companies determine specific adaptations and marketing strategies. In addition, variety test data become a part of a historical base that is used by researchers and others to evaluate changes and trends. Thus, it is important that these data truly represent the relative performance of the varieties in the specified testing conditions.

Unfortunately, biases (inherent to all variety testing programs) are caused by certain unavoidable differences and the employment of specific test management and sampling procedures. Some can be lessened or eliminated by following established guidelines. An ad hoc committee formed by the Southern Regional Information Exchange Group (SRIEG-61) established a list of cotton variety test recommendations (Bowman, 1997). These are strictly followed by the Arkansas Cotton Variety Testing Program. But practically, several other biases can only be recognized, then considered with interpreting data.

To better understand biases inherent to the Arkansas Cotton Variety Testing Program, this paper summarizes changes that have occurred in the program since 1970 (first year that the senior author had any association with the test) and examines potential inherent biases in three general areas: seed and seedling, variety specific management, and sampling and ginning.

Changes in Arkansas Cotton Variety Test Since 1970

Although experimental design has remained constant (except for variation in number of replications over years), several changes in the methods of seeding, managing and harvesting plots have occurred in the Arkansas Cotton Variety Testing program since 1970. Testing has been expanded to include duplicate, non-irrigated tests at two of the four locations. Also, the use of load cells on boll buggies have allowed large-plot cotton variety trials located in commercial production fields to become true tests rather than demonstrations. Selected varieties are now evaluated in these large-plot tests and the resulting data are used to confirm and compliment data from small plots.

Perhaps the most significant change in the Arkansas Cotton Variety Test has been the number of entries. The number steadily increased from 14 in 1970 to 47 in 1995. The number decreased to 30 in 1996, the first year that transgenic varieties were included in the test, but has more than doubled since then, with a record number tested (67) in 1999. The number of transgenic varieties in the test has increased from 6 in 1996 to 25 in 1999.

With the size and variation in fields used in the Arkansas testing program, fair testing of entries becomes complicated when the number of entries are much greater than 30. In the past, number of replications was increased to six and covariant plots were used to increase precision of testing large numbers of entries. In other states, number of entries within a test has been reduced by separating entries into two tests based on their relative maturity.

Separating entries by maturity was not practical in our program because late-maturing varieties have little application in north Arkansas, and available land and space prevents managing tests differently by maturity. To reduce size of the 1999 test, entries were separated into two tests based on whether they were returning entries. First, the 1999 Arkansas Cotton Variety Test consisted of 32 (20 conventional and 12 transgenic) entries, all of which were in

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the 1998Arkansas Cotton Variety Test. A second test (the 1999 Arkansas First-year Cotton Variety Test) had 37 entries, 22 conventional and 13 transgenic first-time entries plus 2 check varieties (common to both tests). Replications of the two tests were alternated in the field. If lint yields of the common entries had varied significantly between the two tests, yields of all entries in the first-year test would have been adjusted to reflect the difference. Such an adjustment would facilitate fair calculation of 2-year means for entries returning to the test next year.

Inherent Biases - Seed and Stand

Inherent differences exist among variety test entries in the quality of seed and the subsequent quantity and quality of stand. Seed used for the variety tests are obtained directly from seed companies and/or breeders. Thus, they may vary in the location where produced, fungicide treatment and grading (size variation). Insecticidal seed treatments are not permitted, and thus does not vary.

Packaging seed with a seed counter allows us to plant a constant seeding rate. Seeding rates are increased for specific entries when the provider indicates a need to compensate for low germination of a seed lot. A relatively high seeding rate (4-5 seed/row foot) lessens the chance of having to re-plant or spot-plant. However, poor stands of some entries sometimes occur. When found early, remnant seed are used to spot-plant skips. If not spot-planted, plot lengths are adjusted for short skips by determining the distance between extended branches at the end of the season. Single plots may be discarded if stand cannot be remedied. If stand is sparse in all replications, an entry may be discarded and re-planted with filler so that adjacent plots are not given an “outside-row” advantage.

The relatively high seeding rate along with procedures to remedy and/or adjust for skips provides a slight advantage to entries with less than highest quality of seed. Such entries tend to achieve an optimum stand density, while plant stands of entries having better seed quality may be thicker than desired. Conversely, entries having high seed quality should have an advantage of having higher seedling vigor.

Inherent variation in seed quality becomes a question of whether the primary concern is testing the “genetics” or the “product” (genetics, quality control, delivery, etc.) of the variety. Variety testing procedures do not the separation of “genetics” from the “product”. Producers are essentially concerned with the “product”, while seed companies are primarily concerned with “genetics” since they can alter quality control and delivery.

Inherent Biases - Variety-Specific Management

Ideally, each variety within a test would receive the optimum timing and rates of management inputs so that its genetic potential within an environment could be achieved. Such variety-specific management is unknown for many factors (e.g. fertilizer rate) and, if known, would cause much criticism if varieties within a test were treated differently. Following are some characteristics which may cause certain management practices to give an advantage to some varieties.

Maturity

Probably, the largest potential bias in our program is associated with differences in plant maturity. As indicated above, varieties are not separated by maturity. Research assistants who are responsible for management at the different location are instructed to base timing of in-season inputs (e.g. fertilizer, irrigation, defoliation) on the average maturity of entries in the test. For years, the senior author felt that this management approach was a slight advantage to early-maturing varieties. However, precise relative maturity of varieties in the 1999 test was determined with the nodes-above-white-flower (NAWF) measurement, described by Bourland et al. (1987, 1992). These data strongly suggested that insecticide termination and defoliation was later than optimum in 1999 for the varieties with median maturity, thus, favoring late-maturing varieties over early-maturing ones.

Plant Height

Plant height of varieties may vary greatly, and excessive plant height can be controlled with applications of mepiquat chloride (Pix®). The primary effect of mepiquat chloride is to shorten plant internodes. Mepiquat chloride applications can positively and negatively affect yield of tall-stature and short-stature varieties, respectively, in the same test (Niles and Bader, 1986). However, the Arkansas Cotton Variety Test does not typically include varieties that differ as much in plant height as those evaluated by Nile and Bader.

Research assistants in Arkansas are instructed to apply low rates of mepiquat chloride prior to flowering if excessive plant height is expected. Applications are never made to the non-irrigated tests. When used, mepiquat chloride applications might provide a slight advantage to tall-stature varieties.

Insect Resistance

Uniform insecticide treatments are made to all plots at a test site. This typically includes an in-furrow systemic insecticide and other treatments based upon insect scouting of the field. Insect resistant lines (particularly Bt varieties) obtain a distinct advantage because they are treated with insecticides that they might not otherwise receive. Thus, insect populations below treatment thresholds are lessened.

Herbicide Resistance

Regardless of genetic resistance to herbicides, all entries within a test receives the same herbicide treatment, as recommended for conventional cotton varieties in Arkansas. Such treatment might be a disadvantage to a resistant line if a variety by herbicide treatment interactions were known to exist.

Inherent Biases - Sampling and Ginning

In most cotton variety testing programs, small samples of seedcotton are ginned to determine lint percentage from boll samples (or gin turnout from grab samples) and fiber properties. Hand-harvested, 50-boll samples are used in the Arkansas Cotton Variety Testing Program rather than grab samples because (1) there is less conflict with mechanical harvest (fewer sampling errors and less time required during harvest), (2) an estimate of boll size can be calculated, and (3) less plant material (trash) is in sample. Since our lab gin does not have a lint cleaner, an advantage to varieties that tend to have more trash in machine-harvested samples (e.g. tall, late-maturing varieties) may be gained.

The greatest concern with boll sampling is whether a fair sample of bolls is obtained since there is a tendency to harvest larger bolls and avoid lowest bolls on the plant. We initiated the use of a "differential boll sample" in 1999. From adjacent plants, individuals are instructed to pick a boll from the bottom four fruiting branches of 10 plants, a boll from the central fruiting region of 10 plants, and top bolls from 5 plants. The procedure is repeated in the adjacent row of the plot to establish a 50-boll sample.

Ginning boll samples on a lab gin which does not have a lint cleaner exaggerates both turn-out and, subsequently, lint yield. Typically, the exaggeration is similar for all varieties, so that lint yields can be compared. However, since hairy leaf varieties might require more lint cleaning (in a commercial gin) than smooth leaf varieties, estimate of turn-out with a lab gin may be an advantage to hairy-leaf varieties.

Conclusions

There are several inherent biases that cannot practically be eliminated from cotton variety testing programs. Attempts are made in the Arkansas Cotton Variety Testing Program to be as fair and unbiased as reasonably possible. When interpreting data from our program, the inherent biases discussed above should be considered.

Results of variety testing should be used primarily to determine the agronomic adaptation (morphological, maturity, yield, and fiber traits). Auxiliary testing is needed to determine other varietal characteristics (e.g. host plant resistance and environmental and chemical tolerances) and relative value of a variety within a system.

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