Efficiency of the Simple Lattice Design Relative to Randomized Complete Blocks Design in Cotton Variety and Strain Testing

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COTTON breeders and agronomists are faced with the problem of the selection and evaluation of available experimental designs. No account has appeared in the literature of an investigation of the efficiency of lattice designs relative to the randomized complete block design in cotton variety and strain testing. Also, little information is available concerning the accuracy of lattice designs with 25 and less varieties for any crop.

The objectives of this paper are to present and examine the relative efficiencies obtained from the analyses of 38 simple lattice designs in cotton variety and strain testing conducted in Alabama and Georgia during the years 1943-47, inclusive. There were 28 experiments of 16 varieties, 9 of 25, and 1 of 36. Since these numbers of varieties are relatively few and the numbers of replications are relatively many for simple lattice designs, these trials might have been somewhat more efficiently performed by using a different type of lattice design, for example, the balanced lattice or the lattice square design. In this connection, it should be noted that the statistical analyses would be simpler for the latter two designs.

Review of Literature

Since the time of the first description of the lattice designs by Yates (16) and Goulden (7,9) and the subsequent papers by Yates (17, 18, 19) and Cox, Eckhardt, and Cochran (6) giving the more accurate methods of analyses, several papers have been published in which is discussed their efficiency relative to randomized blocks. Yates (16), Goulden (8), and Zuber (20) studied the question of efficiency by superimposing various lattice designs and corresponding randomized blocks on uniformity data on oranges, sugar cane, sugar beets, potatoes, barley, wheat, and corn. Cochran (3) has pointed out that this method permits variation of size, shape, and dimensions of plots, incomplete blocks, and replications. However, it is limited by the amount of available uniformity data for any particular crop, and the extent to which the fields selected for uniformity trials are truly representative of the fields usually allocated to experiments on that crop.

The arrangement of the incomplete blocks into groups in order to form complete replicates of the varieties makes it possible to analyze the data as a randomized complete block experiment, as well as an incomplete blocks or lattice experiment (18 and 6). These two analyses provide a means of obtaining the relative efficiency of the lattice design to the randomized design.

Studies of the relative efficiencies of the simple lattice square designs have been made by Cochran (4) and Warner (17), for the lattice square design by Bliss and Clagett (5) for sugar beets in Colorado, and for the balanced lattice by Wellhausen (15) for corn in Pennsylvania. The last two papers mentioned also furnish some information concerning the accuracy of lattice designs with 10 varieties, respectively. While lattice designs have been found useful for variety trials involving 25 or more varieties, gains in efficiency over the randomized block design are dependent on experimental material and variety number range.

Cochran (4) discussed the lattice designs for trials with reference to available uniformity data and pointed out that a study of relative efficiencies be made for crops such as corn. It may be of some interest to note that Pope and his coworkers (13) have studied the use of the cubic lattice design by analyzing data from an 80-inbred-strain trial for cotton.

Material and Methods

Material for study was made available by both State and Federal workers in Alabama and Georgia. Several experiments, conducted in 1944, and 1945, were conducted in Georgia by the junior author. Acknowledgment is made to Mr. W. W. Ballard and Mr. H. B. Tisdale for information on five tests conducted jointly with the junior author in 1946 in Georgia, as well as from eight additional tests conducted in Georgia in 1945, all of which are due also to Mr. H. B. Tisdale for results of investigations jointly with the junior author in Alabama in 1945. The results represent tests conducted cooperatively in Georgia and the Main and Branch Experiment Fields in Alabama and Georgia. Of the 38 tests conducted, nine were on Piedmont soils of the Central and Upper Coastal Plain soils, while only three were on Lower Coastal Plain soils.

The cultural practices used in both Station and field tests were those in common use by cotton growers. The rate of fertilizer varied from test to test within a range of 20-300 pounds per acre. The fertilizer formula likewise varied somewhat, but consisted of a 6-8-6, 6-8-4, 4-10-7, or similar combination, with 100 to 200 pounds per acre of nitrogen. After chopping was practiced on the lighter soils, cotton was dropped and the plants thinned later to a stand. The yield data used in all analyses were field weights of seed cotton. Where stands were uneven, skips were measured before picking and adjusted according to the percentage of seed. The data for the individual plot yields were adjusted according to the percentage of seed.