

# Comparison of Statistical Designs for a Large Number of Entries of Sugar Beet Strains

H. L. BUSH AND R. K. OLDEMEYER<sup>1</sup>

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Field testing of a large number of entries presents a problem when the results are interpreted, since the results may reflect soil variation from the rather large area which is covered by each replicate.

The familiar Lattice Designs<sup>2</sup> were developed for the purpose of minimizing heterogeneity by means of statistical analyses. However, difficulties arise with these designs when seed quantities are low or of poor quality so that there may be some variation in the possible number of replicates for some lots. Also, due to poor stands, some plots may be lost, necessitating the calculation of missing plot values.

In an attempt to provide a scheme which was not as fixed in its basic design, whereby the number of entries or number of plots for each entry was not vital to the design, a scheme<sup>3</sup> was devised so that 2 plots of a "control" or check variety were included in each block which also contained 10 entries of the strains under consideration. Results for each plot were then calculated in "% of check" before being averaged. The Standard Error value obtained from the check variety could be taken as an estimation of the variability that might be applied to all entries. This design, as it has been used, has given highly satisfactory results. However, as the number of entries increased, it became evident that it was inefficient from the land-usage standpoint, as well as labor costs, since approximately 17% of the plots of a 10 entry block were planted to the control variety.

It was decided in 1958 to determine the precision of this method as compared with the Lattice Design, since the Control Block Design appeared to be getting unwieldy. In order to make this comparison, a Simple Lattice Design composed of 100 top-cross lines in 4 replicates was set up. Two plots of the control variety were then added in a random location within each block of the lattice. The data were analyzed according to both schemes.

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<sup>1</sup> Statistician-Agronomist and Director of Seed Development, respectively, Great Western Sugar Company, Longmont, Colorado.

<sup>2</sup> Cochran, Wm. G., and Cox, Gertrude M. 1957. *Experimental Designs*. 2nd Edition. John Wiley and Sons, Inc., New York 1, N. Y.

<sup>3</sup> Credit is given to Dr. LeRoy Powers, U. S. Department of Agriculture, for suggesting this type of design.

The performance of the top crosses calculated from the control block design deviated, plus or minus, from the performance calculated by the lattice design. Tables 1 and 2 summarize the deviations for yield of roots and sugar content. The bulk (83) of the observations do not deviate more than 5% from one method to the other while 15 of the entries give the same results (within 0.5%) by the two methods. When this is considered in the light of the wide range of performance of the entries, 65-135% of the check, this deviation is of minor importance.

Table 1.—Root Yields for Top-Crosses as Indicated by the Lattice Design Compared with Those Obtained by Control Block Design.

Top-Crosses	Deviation of Block from Lattice Results
(No.)	(%)
1	-10
1	-9
2	-8
2	-7
3	-6
5	-5
4	-4
6	-3
8	-2
9	-1
15	0
8	+1
7	+2
8	+3
6	+4
7	+5
1	+6
3	+7
2	+8
1	+9
0	+10
1	+11

Using the same method of comparison for sugar content, Table 2, the deviation is even smaller than for yield of roots. The range of performance for this character was 80-118% of the check. In this case, 96 of the observations deviated 2.5% or less for the two designs and 24 of the entries were the same (within 0.25%).

Inasmuch as gross sugar production is a function of root yield and sugar content, a table for comparing the two methods is not presented for this character.

The two designs have also been compared in another manner whereby standards have been set for the inbred top crosses, expressed in percent of the check strain, of 104% or less for discontinuance of the inbred line, 105-114% for retesting and 115%

Table 2.—Sugar Content for Top-Crosses as Indicated by the Lattice Design Compared with Those Obtained by Control Block Design.

Top-Crosses	Deviation of Block from Lattice Results
(No.)	(%)
1	-3.0
5	-2.5
2	-2.0
6	-1.5
12	-1.0
14	-0.5
24	0
12	+0.5
5	+1.0
6	+1.5
4	+2.0
6	+2.5
1	+3.0
0	+3.5
0	+4.0
2	+4.5

or more for increase. These standards apply particularly to yield of roots and gross sugar. Comparing the data from the two designs for root yield, 9 entries would indicate a retest by one design and discontinuance by the other. Considering gross sugar, 8 inbreds would be shelved by one design and retested by the other; 5 would be increased by one scheme and retested by the other. In no instance for either root or gross sugar yield was the deviation great enough that an inbred would be discontinued as the result of one design and increased as the result of the other, which would indicate that we would not discontinue any of the better lines by either scheme.

The Lattice Design was used for the 1959 tests and these data indicate a high degree of reliability as judged from the similarity of results obtained from testing related lines.

The authors have concluded that the Lattice Design is sufficiently accurate to be used in testing the bulk of the hybrids, and due to the considerable saving in number of plots to be tested, is probably preferable to the Control Block Design. For testing hybrids of questionable germination or those which are limited in seed, the Control Block Design will continue to be used.