Comparative Efficiency of Lattice and Random-Block Designs for a Sugar-Beet Variety Test[1]

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Thirty-six sugar-beet varieties were included in a lattice design of three replications according to the methods of Cox and Eckhardt[3] and Cochran.[4] The plots were 60 feet long and four 20-inch rows wide. All the beets were harvested from the 2 inside rows of each plot and were washed before being weighed. Only the acre yields of roots are reported.

Analysis of Variance for Randomized Blocks

Variance due to	D/F	Mean Squares	F	
Replication	2	1.7004		
Varieties	35	6.3800	1.69	(Slightly exceeds
Blks. × Var. (Er.)	70	3.7737		5 percent point)
Total	107			

Standard error of the mean in percentage of the general mean 7.26 percent
Two times the standard error of a difference 3.17 tons

Analysis of Variance for Lattice Design

Variance due to	D/F	Mean Squares	F	
Replication	2	1.7004		
Blocks (eliminating variety effect)	15	11.6518		
Varieties (ignoring blocks)	35	6.3800	4.00	(Exceeds
Error (intra-block)	55	1.6252		1 percent point)
Total	107			

The mean standard error of all comparisons is 3.133 tons.

The analyst of variance for a randomized-block test shows that, in spite of relatively high variability in the experiment as a whole, very little of the variance is attributable to block effect. The *F* value, while low, does indicate that statistically significant differences in the yield of the varieties are shown by the test.

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[3] The Analysis of Lattice and Tripe Lattice Experiments in Corn Varietal Tests. Part I. Iowa Research Bulletin 2S1. Sept. 1940.

[4] Lattice Designs for Wheat Variety Trials. Jour. Amer. Soc. Agron., Vol. 33, PP. 351-360. April 1041.

The analysis of variance for the lattice design shows that a very large portion of the total variance is attributable to the small, six-variety blocks. It should also be noted that a much higher F value for varieties is obtained. Statistically the lattice design was found to have 196 percent of the efficiency of the random-block design in this test.

Table 1.—Mean yields of the randomized-block test and corrected rnean yields the lattice-design test ranked in the order of yield of the varieties.

	Randomized-Block Test (Means of 3 plots)		Lattice-Design Test (Corrected Means)	
Rank	Variety No.	Yield	Variety No.	Yield
		(tons)		(tons)
1.	17	18.13	17	19.97
2.	24	18.10	11	18.89
3.	12	17.74	12	18.72
4.	11	17.31	29	17.86
5.	35	16.70	30	17.66
6.	30	16.67	7	17.13
7.	13	16.67	13	17.05
8.	34	16.59	35	17.05
9.	31	16.41	36	16.73
10.	7	16.37	34	16.72
11.	26	16.14	13	16.54
12.	22	16.12	16	16.34
13.	2	16.09	31	16.18
14.	6	15.91	24	16.06
15.	32	15.83	10	15.85
16.	18	15.75	2	15.63
17.	24	15.65	6	15.58
18.	16	15.61	26	15.27
19.	19	15.51	27	15.20
20.	27	15.45	32	15.19
21.	36	15.45	22	15.08
22.	33	15.31	10	15.05
23.	21	15.28	9	14.72
24.	10	15.18	21	14.71
25.	9	15.13	3	14.64
26.	3	15.05	23	14.63
27.	25	14.38	33	14.25
28.	8	14.21	15	13.91
29.	28	14.17	5	13.89
30.	23	14.14	25	13.76
31.	15	13.95	8	13.51
32.	5	13.79	28	13.12
33.	1	13.70	1	12.82
34.	14	12.88	14	12.70
35.	20	12.62	20	12.65
36.	4	11.81	4	10.74

The mean yields and the adjusted mean yields of the varieties are given in table 1 in the order of the varieties' yields. Of the five highest-yielding varieties, the variety which was ranked as fifth according to the randomized-block design was changed to eighth in the corrected yields, and sixth was raised to fifth. The four lowest varieties were the same and in the same order by both analyses. It was found that Numbers 22 and 32 were in the top ranking 18 of the random-block test and fell to twenty-first and twentieth place, respectively, in the corrected yields; while Numbers 36 and 19, which were twenty-first and nineteenth, respectively, in the random-block test, were raised to places among the top-ranking 18 in the corrected yields. This would be important if only the 18 best varieties were to be saved in a breeding program. When all varieties with yields above the mean of the random-block test are selected, both designs include the same varieties in the first twenty-one places.

In this case the adjustment of means had little effect on the varieties which might be selected for further study in a breeding program. Thus the 196 percent statistical efficiency did not indicate that the biological choice of selection would be approximately twice as good when based on the lattice design as when based on the randomized-block design.

In case of missing plots the data from one or more plots of a test will be lost. Such loss of data may occur when a large number of selections, made in the early stages of a breeding program, are under test. Adjustments for the loss of data for any plot or for any variety are relatively simple in the case of randomized-block designs, but such adjustments have not been worked out for lattice designs such as this one, in which partially adjusted plot yields are used.