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ERROR REDUCTION IN FIELD EXPERIMENTS ON *HEVEA* USING COVARIANCE TECHNIQUES AND EFFECTIVE BLOCKING

By

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SUMMARY

Four-tree plots and single-tree plots were studied separately in completely randomized and randomized complete block designs in order to study the suitability and efficiency of four calibrating variates, viz: bark thickness, trunk girth, height up to the first main branch and the number of main branches, in the significance of covariance adjustments of the latex yield.

Only bark thickness and trunk girth proved to be efficient. Four-tree plots gave better results when the blocking out was done first, and a double covariance adjustment followed for the bark thickness and the trunk girth.

INTRODUCTION

In field experiments on rubber, non-uniformity of experimental units at the start of the experiment, which may be due to the variation in soil characteristics and inherent differences of individual plants, might cause a higher variability in initial yields thus keeping the experimental error at a high level, thereby lowering the experimental precision. Therefore, the experimentor is obliged to try to reduce this error.

Several statistical techniques have been adopted to reduce this error, with the aim of increasing the precision of the experiment concerned. Among these techniques, covariance adjustment and effective blocking play a major role.

The method of covariance, introduced by Fisher (1934), has been widely used. Federer and Schlottfeldt (1954) have illustrated an example where quadrati covariance analysis was used to control an unexpected gradient in fertility within replication of an experiment on tobacco. Fairfield Smith (1957) in his study on analysis of covariance deals with concomitant variables which may not necessarily be factors causally affecting the variate. Irma (1957) has developed a technique for the evaluation of missing plots, which is also a valuable consequence of covariance analysis. Most of these studies give detailed illustrations. Cochran (1957) also describes various aspects of covariance, he has referred to effective blocking as an alternative approach to reduce error. However, in the present study, blocking and covariance adjustments are done for the same experiment successi ely, in order to study the increase of precision when both the techniques are used.

The object of this study is to identify suitable calibrating variates in *Hevea* trees which could be used to reduce the error by adoоting covariance techniques. Since the use of pre-experimental latex yield to reduce error delays the exрeriment for a considerable time in order to collect such data it is the aim of this study to find suitable time-saving covariates such as trunk girth, bark thickness, height, number of branches etc., which could be measured instantly. The efficiency of these covariates is studied with the changing plot size and the design. The influence of effective blocking is also studied.

TABLE 1. SUMMARY OF ALL THE RELEVANT 'ANOVA' TABLES

TECHNIQUE		*FOUR-TREE PLOT*				*SINGLE-TREE PLOT*			
		E.M.S.	*F*	*C.O.V.%*	*Gain in Precision %*	*E.M.S.*	*F*	*C.O.V.%*	*Gain in Precision %*
Completely Randomized Design	(Without covariance adjustments)	102.781	1.0135(N.S.)	24.44	—	318.7471	2.1944(N.S.)	39.15	—
do	(After adjusting for x1)		No Significant Improvement			248.5446	2.6079(N.S.)	34.57	28
do	(After adjusting for x2)		do				No Significant Improvement		
do	(After adjusting for x3)		do				do		
do	(After adjusting for x4)		do			273.3274	2.9638 *	36.25	17
Randomized Complete Block Design	(Without covariance adjustments)	50.23.77	1.9725(N.S.)	17.09	105	194.5536	4.7665 **	30.58	64
do	(After adjusting for x1)	16.1130	11.5982 ***	9.68	538	123.9678	5.2012 **	24.40	157
do	(After adjusting for x2)		No Significant Improvement				No Significant Improvement		
do	(After adjusting for x3)		do				do		
do	(After adjusting for x4)	23.7293	7.1068 **	11.74	333		do		
do	(After adjusting for x1 and x4)	11.6011	17.3030 ***	8.21	786		do		

N.S.:—Not significant, * P 0.05 — 0.01, ** P 0.01 — 0.001, *** P < 0.001

X_1, X_2, X_3 and X_4 are the pre-experimental trunk girth, height, number of branches and bark thickness respectively.

Materials and Methods

Eighty, *Hevea* trees were selected from an eighteen-year old PB 86 plantation. Trunk girth, bark thickness, height up to the first main branch and the number of main branches were measured for every tree, and recorded. Latex yield was also collected over a considerable period. Yield, as dry rubber content was measured and recorded for each tree.

Four dummy treatments *viz*: (1) zero units of fertilizer (2) 10 units of fertilizer (3) 20 units of fertilizer and (4) 30 units of fertilizer whose effects, assumed to be 0, 10, 12 & 13 yield units respectively, were used in the analysis. These treatments were used in completely randomized and randomized complete block designs separately, with four-tree and single-tree plots. Covariance adjustments were carried out for the above covariates, with the changing design and the plot size. All the mathematical models and methods used are given by Cochran (1957) and Federer (1955).

Results and Discussion

The summary of all the relevant analyses of variance is given in Table 1. Error Mean Square (E.M.S.) in the ANOVA is a satisfactory index of our experimental error. Table 1 shows how this error could be reduced by nearly 50% if the same experiment was carried out as a randomized block design with effective blocking. In this case blocks were taken along the contours. Variability among the experimental units could also be reduced by this blocking as evident from the reduction in the coefficient of variation (C.O.V.). Further, this effective blocking did also lead to significant results. Percentage gain in precision was calculated with respect to the Error Mean Square of the ANOVA of the completely randomized design without any covariance adjustment. The reduction in error and the coefficient of variation and the increase in precision, by subsequent covariance adjustments, are also shown in Table 1.

It is shown from this study that, for all the techniques used, four-tree plot size was preferable to the single-tree plot in the reduction of error. In both the cases, only trunk girth (x_1) and bark thickness (x_4) proved to be efficient calibrating variates. It could also be argued that, since these two are also correlated, we were measuring the same character as the covariate and hence the need for the adjustment. But, it was observed that when combining these two in the double covariance with the post-experimental yield in the randomized block design, a higher correlation and a considerable gain in precision, compared to the single covariances with these covariates was shown. Further studies are contemplated to ascertain how far this is generally applicable.

This suggests that when the plot size is large, it is advisable to reduce the experimental error, first by effective blocking of the experimental area, and then by subsequent double covariance adjustment for trunk girth and bark thickness.

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