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OPTIMUM PLOT SIZE FOR COCOA THROUGH MULTIVARIATE ANALYSIS

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Abstract: Optimum plot size was determined for cocoa in the multivariate case by considering three characters viz., canopy spread, yield and girth. Single tree plot was found optimum by the method of maximum curvature as well as by minimising the number of trees required to achieve 5% error.

INTRODUCTION

Determination of optimum size of plots has so far been based on a single important character. Pearce and Thom (1951) found that a plot should be as small as 0.15 acre for an accurate experiment with cocoa. Sheela and Unnithan (1989) estimated four tree plots to be optimum for cocoa on the basis of variability in yield. Sheela (1987) developed a procedure to determine the optimum size of plot in multivariate case using determinant of relative scatter matrix as the measure of variability. Determination of optimum plot size for cocoa by simultaneous consideration of three characters viz., canopy spread, yield and girth was attempted herein.

MATERIALS AND METHODS

Observations on three characters viz., canopy spread, yield and girth at 15 cm height for 738 Forastero variety of cocoa (*Theobroma cacao* L.) maintained in KADP farm, Kerala Agricultural University, Trichur have been used for the present study. Cocoa being a perennial crop, individual trees were taken as the smallest unit on which observations were taken.

Plot formation

The whole set of trees were divided into compact blocks of sizes 5, 10 and 15 and plots of 1 to 15 trees were formed by combining adjacent trees in the field. In the case of no blocking, the whole set of trees was considered as a single block. The relative scatter matrix was defined as

$$S = (S_{ij})_{p \times p} \quad \text{where}$$

$$S_{ij} = \frac{\left[\sum_{k=1}^{p} (X_{ij}\ X_{jk} - N\ \bar{X}_i\ \bar{X}_j)\right]}{N\bar{X}_i\ \bar{X}_j}$$

$i, j = 1, 2, 3, \ldots\ldots, p \qquad \ldots (1)$

where X_{ik} is the observation on i^{th} character on the k^{th} unit, $\bar{X}_i$ the mean per unit of the i^{t} character and N the total number of units.

Determinant of S ($|S|$) was used as the measure of variability and the optimum plot size was determined using two methods.

1. Method of maximum curvature

The Smith's model

$$Y = ax^{-b} \qquad \ldots\ldots(2)$$

was fitted for $|S|$ against the plot size 'x' for various sizes of block. The optimum size of plot was determined by the calculus method of maximum curvature using the formula (Gopakumaran, 1984)

Table 1. Number of replications and trees required to attain 5% error along with |S| for different sizes of plots and blocks

Plot size	Without blocking			5 plot block			10 plot block			15 plot block		
	$\lvert S\rvert \times 10^5$	No. of replications for 5% error	No. of trees for 5% error	$\lvert S\rvert \times 10^7$	No. of replications for 5% error	No. of trees for 5% error	$\lvert S\rvert \times 10^5$	No. of replications for 5% error	No. of trees for 5% error	$\lvert S\rvert \times 10^7$	No. of replications for 5% error	No. of trees for 5% error
1	47.477	29	29	34.760	6	6	4.279	14	14	4.726	14	14
2	8.295	17	34	55.739	7	14	0.229	5	10	0.872	8	16
3	3.110	13	39	28.781	6	18	0.544	7	21	2.508	12	36
4	1.768	10	40	4.180	3	12	0.699	8	32	1.136	9	36
5	1.019	9	45	11.048	4	20	0.394	6	30	0.465	7	35
6	0.738	8	48	0.633	2	12	0.152	5	30	0.351	6	36
7	0.453	7	49	11.444	4	28	0.159	5	35	0.185	5	35
8	0.312	6	48	0.282	2	16	0.019	2	16	0.051	3	24
9	0.272	6	54	0.041	2	18	0.014	2	18	0.034	3	27
10	0.249	5	50	3.000	3	30	0.023	2	20	0.024	3	30
11	0.198	5	55	0.268	2	22	0.013	2	22	0.021	2	22
12	0.147	4	48	0.176	2	24	0.006	2	24	0.012	2	24
13	0.130	4	52	0.574	2	26	0.037	3	39	0.064	3	39
14	0.119	4	56	0.586	2	28	0.013	2	28	0.016	2	28
15	0.082	4	60	0.216	2	30	0.007	2	30	0.027	3	45

$$X_{opt} = \left[(ab)^2 \, (2b+1)/(b+2)\right]^{1/2(b+1)} \quad \text{..... (3)}$$

2. Minimisation of number of experimental units to achieve P% error

The minimum number of replications *T*, required to achieve P% error is given (Sheela, 1987) by

$$Y = \frac{|S|^{1/p}}{(P/100)^2} \quad \text{..... (4)}$$

The number of trees required to achieve P% error was obtained by multiplying the number of replications required to achieve P% error by the corresponding plot size. The plot size which requires minimum experimental area for a specified precision was considered optimum.

RESULTS AND DISCUSSION

The determinants of the relative scatter matrices (|S|) of plots of size ranging from 1 to 15 adjacent trees have been calculated using (1) with no blocking and blocks of sizes 5, 10 and 15 and are presented in Table 1. The number of replications required to achieve at least five per cent error along with the corresponding number of trees was also determined (Table 1). Model 2 fitted for (|S|) against the plot size 'x' along with the coefficient of determination is given in Table 2.

Optimum plot size by maximum curvature

Single tree plot was found optimum by the method of maximum curvature in all the cases.

Plot size requiring minimum number of experimental trees

Single tree plots were found optimum for without blocking and blocks of sizes 5 and 15 on cosideration of minimum number of trees required to achieve five per cent error. But in the case of blocks of size 10, the minimum number of trees required to achieve five per cent error was found to be two tree plots.

It may be noted that four tree plots were found optimum (Sheela and Unnithan, 1989) by considering the single important character namely the yield. But single tree plots in general were found optimum by considering three characters simultaneously.

Inference based on multivariate observations has to be relied more than that on a single variable as it is more comprehensive. Hence single tree plots in general can be recommended for experiments with cocoa.

Table 2. Model [$Y = ax^{-b}$] fitted to |S| along with R^2 values

Block size	a	b	R^2
Without blocking	410×10^{-6}	-226×10^{-2}	0.99^{**}
5	119×10^{-7}	-229×10^{-2}	0.64^{**}
10	48×10^{-6}	-225×10^{-2}	0.82^{**}
15	10×10^{-5}	-231×10^{-2}	0.84^{**}

** Significant at 1% level

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