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OPTIMUM PLOT SIZE FOR FIELD TRIALS WITH *COFFEA ARABICA* CV. CAUVERY (CATIMOR)

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SUMMARY

Yield data from two lines of Catimor viz. S. 4345 with 120 plants (10 rows of 12 plants each) and S. 4347 with 100 plants (10 rows of 10 plants each) collected from Coffee Research Sub Station, Chettaiii for three years 1987-88 to 1989-90 were utilized for this study. Plots of different size and shapes were formed combining the adjacent plants yield in row wise and column wise and the corresponding C.V.'s were worked out separately for individual years and then combination of years for both the lines. Fairfield Smith's equation $Y=ax^{-g}$ and the generalisation of this law in the form $Y=ar^{-g1}\ c^{-g2}$ was also tried to compare the heterogeneity of rows (r) and column (c) where **g's** stand for the heterogeneity coefficients for the plot size x with r rows and c columns. Maximum curvature method, graphical representation and the cost of experimentation were tried to work out the optimum plot size. The plot size and shape giving the required information at a minimum cost was taken as optimum. A plot size of 8 plants in a row across the fertility line was found to be the optimum.

INTRODUCTION

In agricultural experiments, the researcher is generally faced with the problem of adopting the suitable size and shape of the plot so as to obtain optimum information from his experiments, judiciously conserving space time and money. The size and shape of the plot depends on the inherent variability present in the crop and the environment in which it is grown. Our problem is to find out the suitable size and shape of plots and blocks for which plot to plot variation is a minimum. Fairfield Smith (1938) worked out the empirical relationship between plot size and the C.V. for yield. Several attempts were made earlier to determine the optimum size and

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shape of plots and blocks for plantation crops. George et al (1979, 83, 84 and 86) worked out the optimum plot size for experiments with Turmeric, Cardamom, Ginger and Cashew. In Coffee'a uniformity trial with S. 288 indicated optimum plot size of 40 plants (Anonymous 1980). Cauvery (Catimor) is a recently introduced semi-dwarf cultivar of coffee which has gained popularity because of its high vigour and early cropping; increased productivity and improved resistance to leaf rust (Sreenivasan, 1989). Optimum plot size required for field trials with this cultivar has not been reported. An attempt was therefore made to a study the size and shape of plot (and blocks) with this cultivar.

MATERIAL AND METHODS

Two lines of Cauvery S.4345 and S. 4347 established in 1982 at Coffee Research Sub Station Chettalli were utilised for the study. Usual spacing of 1.8m x 1.8m was adopted. Ten rows of S. 4345 (12 plants per row) and 10 rows of S. 4347 (10 plants per row) were established. Topping was done uniformly' @ I m height from ground level for both the lines. All cultural operations such as weeding (3rounds) manuring (120:90:120 NPK per annum in 3 split doses) and Bordeaux spray (2 rounds per annum) were given uniformly. Fruit yield data of individual plants were recorded for three consecutive seasons from 1987-88 to 1989-90. However for the analysis for line S. 4347 only 1987-88 and 1989-90 yield data for 10 rows of 10 plants were considered as the yield for 1988-89 was very poor and statistical analysis of fruit yield data indicated significant difference between the two lines and over the years. Plots of varying sizes and shapes were formed combining adjacent units column wise and row wise and later pooled over two years and three years and the corresponding C.V. worked out.

Fairfiled Smith's law $Y=x^{-g}$ was fitted to the relationship between plot size and C.V (y) where g is the heterogeneity coefficient. Generalisation of this law in the form $Y=a\, c^{-g1}\, r^{-g2}$ was also tried to compare the heterogeneity of rows and columns where 'g' s denote the corresponding heterogeneity coefficients.

Maximum curvature method was also tried. The optimum plot size (x) was that value of the size of the plot which lies just beyond the point

of maximum curvature. The curvature at any point is defined by C=Y2/(1+Y1) where Y1 and Y2 are the first and second derivatives of functional form (Y) of the curve. The point at which the curve attains maximum value is obtained by differentiating the expression for the curvature and setting dc/dx to zero. For the Smith function resultant expression is

$$X^{2\,(g+1)} = (ag)^2\,(2g+1)/(g+2)$$

Conventional method of graphical representation of C.V. for the corresponding plot size was also tried for. both the lines for all the years and combinations tried.

The plot size and shape giving the required information at a minimum cost was taken as optimum. The cost of experimentation per treatment

Table 1. C.V. (%) Corresponding to various plot size for individual year combination for S 4345.

Plot Size	87/88	88/89	89/90	87/88+ 88/89	88/89+ 89190	87/88+ 89/90	87/88+ 88/89+89/90
1	59.44	106.66	50.96	42.71	69.13	57.51	50.47
2	43.25	86.74	36.45	32.89	40.90	35.28	31.64
3	35.91	76.86	29.96	28.23	30.08	26.51	24.08
4	31.47	70.54	26.07	25.33	24.19	21.65	19.84
5	28.41	65.99	24.40	23.29	20.43	18.50	17.07
6	26.13	62.50	21.42	21.74	17.80	16.27	15.10
8	22.90	57.36	18.64	19.51	14.31	13.28	12.44
10	20.67	53.67	16.73	17.93	12.09	11.35	10.70
12	19.01	50.83	15.32	16.74	10.53	9.98	9.46
15	17.16	47.55	13.75	15.39	8.89	8.53	8.14
20	15.04	43.64	11.97	13.81	7.15	6.96	6.71
24	13.83	41.33	10.96	12.89	6.23	6.12	5.93
30	12.49	38.67	9.84	11.85	5.26	5.23	5.11
40	10.94	35.49	8.56	10.63	4.23	4.27	4.21
60	9.09	31.45	7.04	9.13	3.11	3.21	3.20
Max. Curva.	8.85			6.74	9.26	8.48	7.91

to estimate the means at 10% C.V. was worked out for different price situations using the cost function $Ck_i = C_1 r + C_2 E$ where Ck_i is the cost of the i th price situation, C_1 is the cost of maintaining an experimental plant and 'r' is the number of replications required. The cost ratios $C_1:C_2$ for price situation K_1, K_2, K_3 and K_4 are 2:1, 3:1, 4:1 and 6:1 respectively.

RESULT AND DISCUSSION

The C.V. (%) corresponding to various sizes of plots for tne years 1987-88, 88-89, 89-90 and their combinations for the line S 4345 (Table 1) shows that the C.V. (%) decreases drastically with the increase in plot size. It can be seen from the table that for the year 1988-89 the C.V. (%) was generally high which was due to the poor yield in some of the

Table 2. C.V. (%) Corresponding to various plot size for individual year combination for S 4347.

Plot Size	87188	89/90	87/88+ 88189
1	8.59	39.18	37.58
2	40.98	34.35	33.61
3	37.10	31.81	31.48
4	34.56	30.12	30.05
5	32.72	28.87	28.99
6	31.29	27.89	28.15
8	29.15	26.4	26.87
10	27.60	25.3	25.92
12	26.39	24.45	25.92
15	24.98	23.44	24.28
20	23.27	22.19	23.18
24	22.25	21.4	22.51
30	21.07	20.5	21.71
40	19.63	19.46	20.73
50	18.58	18.65	20.00
Max. Curva.	6.21	4.45	3.82

plants due to bad weather. The decrease was found to be more drastic in the cases when the data is taken as the average over the years. Table 2 given the C.V. (%) corresponding to the various plot sizes for line S. 4347 for the years 1987-88, 88-89 and 1977-88 + 89-90. In this case also the reduction in C.V. values were observed for the increase in plot sizes.

Table 3. Fair Field Smith's Law $Y=ax^{-g}$ and $Y=ar^{-g1}\ c^{-g2}$ [3x [1x

Lines/years	$Y = ax^{-g}$	$Y = ar^{-g1}\ c^{-g2}$ [3x [1x
S. 4345		
1987-88	59.11 x -0.4489 (R^2 = 0.9901)	59.84 r-0.4631 c-0.4486 (R^2 [3x = 0.9779) [1x
1988-89	111.48 x -0.3319 (R^2= 0.9058)	109.78 r-0.2692 c-0.3776 (R^2[3x =0.9476) [1x
1989-90	48.92 x -0.4453 (R^2 = 0.9672)	51.27 r-0.5474 c -0.3884 (R^2[3x = 0.9497) [1x
1987-88+1988-89	40.74 x-0.3225 (R^2= 0.9524)	40.91 r-0.3305 c-0.3169 (R^2 [3x =0.8687) [1x
1988-89+1989-90	40.47 x-0.5016 (R^2= 0.9902)	50.11 r-0.5399 c-0.4953 (R^2 [3x =0.9614) [1x
1988-89+1989-90	40.47 x-0.4529 (R^2= 0.9099)	41.49 r-5277 c-0.3857 (R2 [3x =0.8835) [1x
1987-88 to 1989-90	39.00 x -0.4703 (R^2= 0.9822)	40.06 r -0.5145 c-0.4427 (R2 [3x =0.9479) [1x
S. 4347		
1987-88	50.81 x-0.2716 (R^2 = 0.9023)	58.03 r-0.5536 c-0.2053 (R^2 [3x = 0.8395) [1x
1989-90	42.17 x -0.2355 (R^2 = 0.8409)	44.68 r-0.4320 c -1965 (R^2[3x = 0.6890) [1x
1987-88+1989-90	40.88 x -0.2127 (R^2= 0.8025)	46.29 r-0.5291 c-0.1562 (R^2 [3x =0.7722) [1x

The C.V. values observed for the different sizes of plots followed closely the Fairfield Smith's law (table 3). The G.V. values determined for various sizes and shapes of plots followed closely the generalisation of Smith's law in the form $y=a\ c^{-g1}\ r^{-g2}$. Though the row wise heterogenity was found to be more than column wise it was not consistant, showing no special significance attached to row wise or column wise blocking. For line S 4345 the point of maximum curvature was found to be around 8 except for the years 1988-89 (12) and 1987-88+89-90 (9), which shows that the optimum plot size required for coffee is around 8 plants per plot (table 1). For line S 4347 the point of maximum curvature was found between 6 and 4, showing a slightly reduced plot size. Figures 1 to 10

Fig. 1 Plot Size in Coffee S.4345 (1987-88)

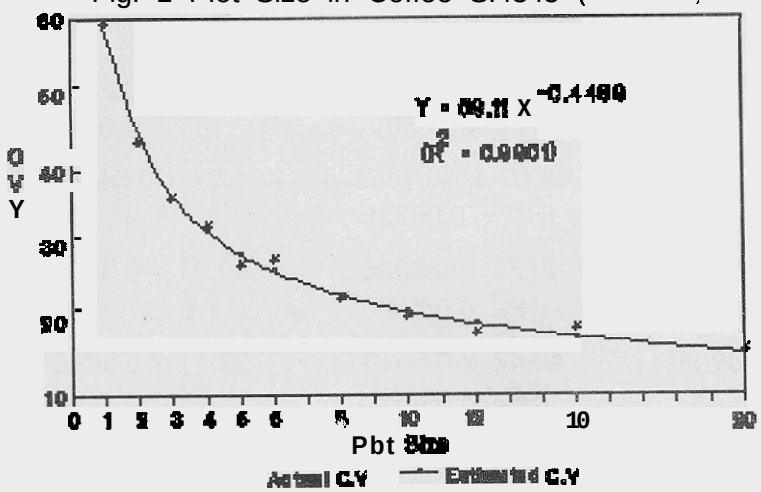


Fig. 2 Plot Size in Coffee S.4345 (1988-89)

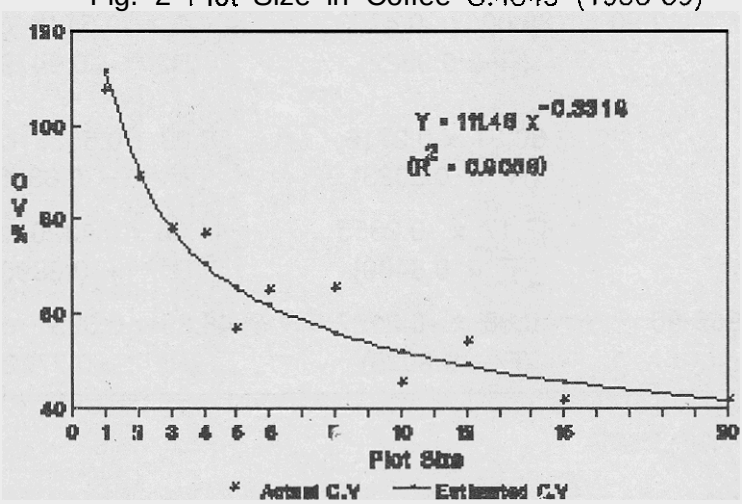


Fig. 3 Plot Size in Coffee S.4345 (1989-90)

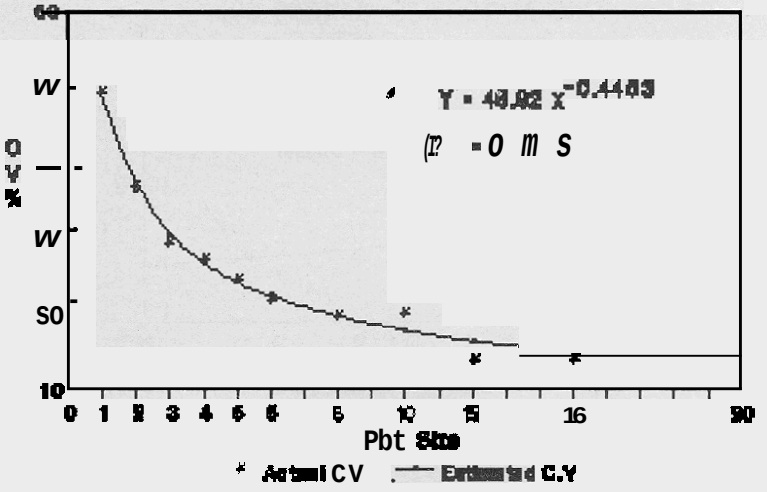


Fig. 4 Plot Size in Coffee S.4345
(Av of 1987-88 & 1988-89)

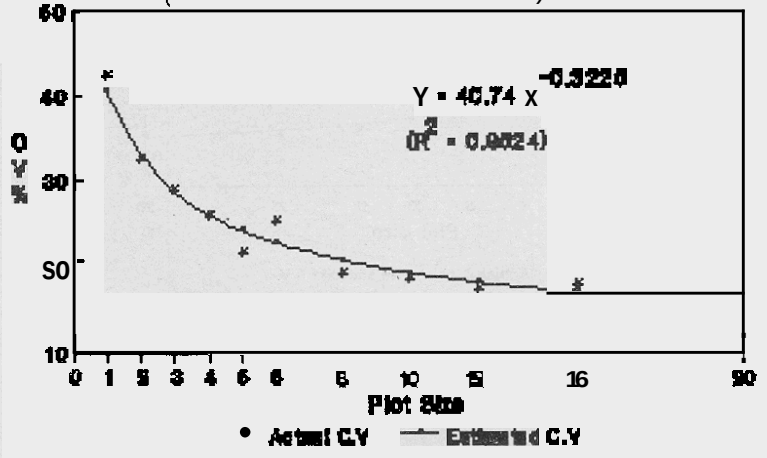


Fig. 5 Plot Size in Coffee S.4345
(Av. of 1987-88 & 1989-90)

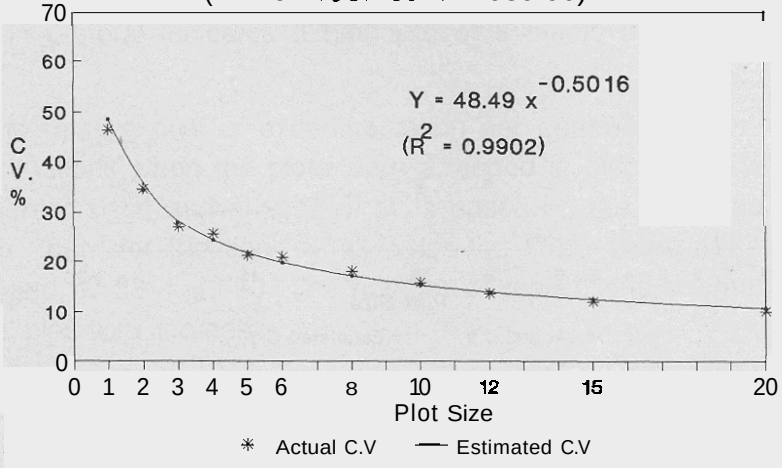


Fig. 6 Plot Size in Coffee S.4345
(Av. of 1988-89 & 1989-90)

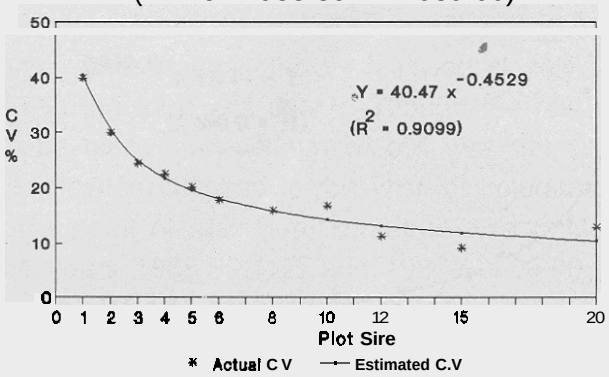


Fig. 7 Plot Size in Coffee S.4345
(Av. of 1987-88 & 1989-90)

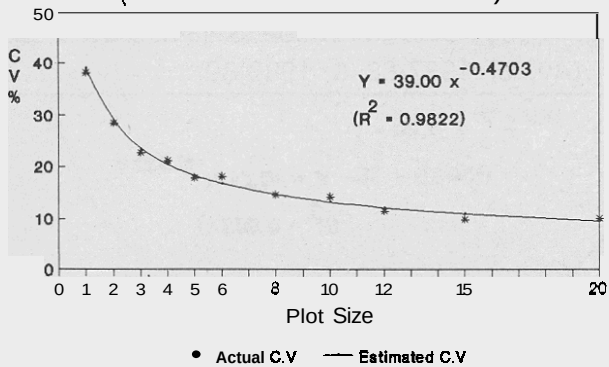


Fig: 8 Plot Size in Coffee S.4347
(Av. of 1987-88)

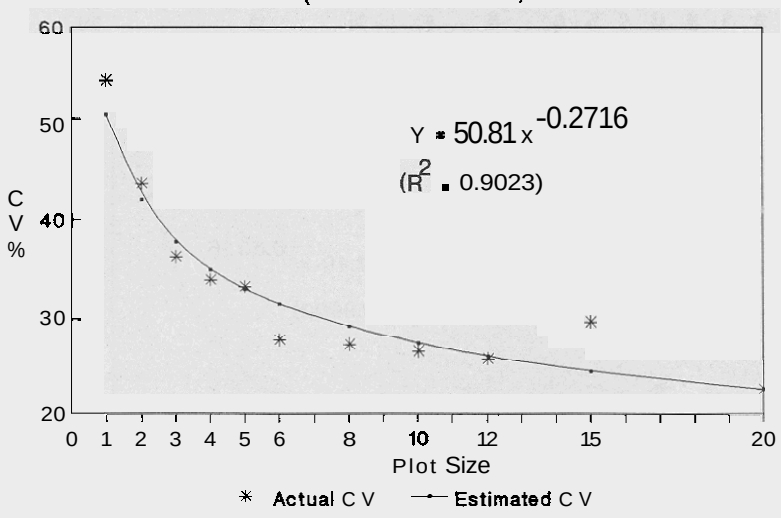


Fig. 9 Plot Size in Coffee S.4347 (1989-90)

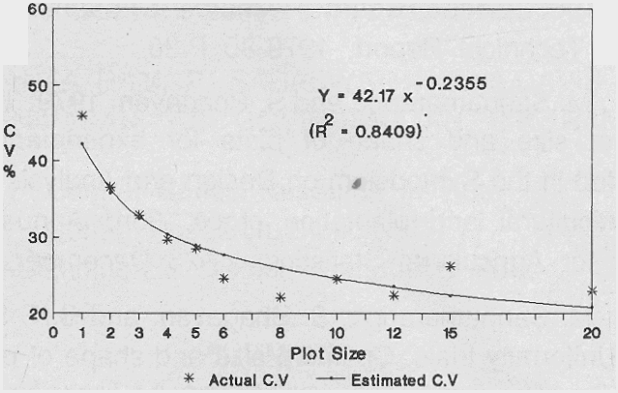
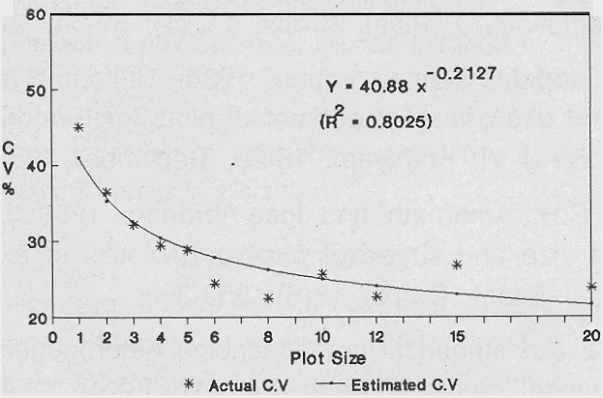


Fig. 10 Plot Size in Coffee S.4347 (87/88+89/90)



are the graphical representations of the various plot sizes, the corresponding C.V. (%) and the curves corresponding to the Fairfield Smith's equations, which in general indicates a plot size of 8 plants as the optimum plot size.

The relative cost of experimentation per treatment under 4 different price situations when the plots were arranged in blocks of 4 and 8 plots for different sizes and shapes of plots based on the observed C.V. was worked out for the line S 4345 for the three years 1987-88, 88-89 89-90 and 87-88 + 89-90. The number of replications decreased rapidly as the plot size increased.

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