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OPTIMUM SIZE AND SHAPE OF PLOTS IN BLOCKS FOR CARDAMOM EXPERIMENTATION*

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ABSTRACT

Fairfield Smith equation with standard notions $Y = 61.66\ X^{-0.332}$ and its generalisation in the form $Y = 63.10\ r^{-0.460}\ c^{-0.272}$ were fitted to the uniformity trial data on cardamom from Mudigere where Y is the C.V. for the plot size X of r rows of c plants each. The heterogeneity between rows was found to be significantly more than that of columns. The cost of experimentation per treatment to estimate the means at 10 per cent C. V. was worked out under different price situations. The plot size and shape giving the required information at a minimum cost was taken as the optimum. Four and six rows of three plants each were found to be the optimum plots for smaller and larger blocks respectively.

INTRODUCTION

The size and shape of plot is mainly decided on the basis of the study of the variability of the soil and environment, apart from the behaviour of the variation in the crop. Smith (1938) worked out an empirical relationship between plot size and the coefficient of variation (C. V.). Eventhough much work has been done in evaluating the optimum size and shape of plots in annual crops, only very little work has been done on these lines in the case of perennial crops. Shrikhande (1957) and Agarwal, Bavappa and Khosla (1968) have worked out the optimum plot size for coconut and arecanut respectively. Abraham, Khosla and Agarwal (1969) worked out the optimum size and shape of plots in blocks for pepper experiments for a given experimental area and with one and two guard rows separately. So far in cardamom no work on these lines has been reported.

Hence an attempt has been made in this paper to work out the optimum size and shape of plots in blocks for cardamom experimentation at different price situations.

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MATERIALS AND METHODS

Weight of green capsule from uniformly grown cardamom plants at 2m × 2m spacing arranged in 36 rows of 12 plants each was individually recorded for the year 1972–'73 at the Regional Research Station, Mudigere, Karnataka. The yields at a few gaps were estimated by the method adopted by Abraham et al. (1968). Plots of different sizes and shapes were formed by combining the adjacent plants and the corresponding C. V. worked out. Fairfield Smith's law $Y=ax^{-g}$ was fitted to find the relationship between plot size (X) and the C. V. (Y) where g is the heterogeneity coefficient. Generalisation of this law in the form $Y=ar^{-g_1} c^{-g_2}$ was also tried to compare the heterogeneity of rows (r) and columns (c) where g stands for the corresponding heterogeneity coefficients.

The plot size and shape giving the required information at a minimum cost was taken as the optimum. The cost of experimentation per treatment to estimate the means at 10 per cent C. V. was worked out under four different price situations K_1, K_2, K_3 and K_4 using the relationship :

$$C_{K_i} = C_1 r + C_2 E + C_3 B \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Where C_{K_i} is the cost for the i^{th} price situation; C_1 is the cost of maintaining experimental plot; C_2 is the cost of maintaining experimental plants; C_3 is the cost of maintaining border plants; r is the number of replications required; E is the number of experimental plants and B is the number of border plants.

The arbitrary cost ratios $C_1 : C_2 : C_3$ for price situation K_1 and K_2 (without borders), K_3 and K_4 (with borders) are 2:4:0; 4:2:0; 2:4:1; and 4:2:1 respectively.

RESULTS AND DISCUSSION

The C. V. decreased with an increase in plot size in both the directions but the decrease was more rapid row wise (Table I). The C. V. averaged over all the different shapes of plots followed closely the relation $Y = ax^{-g}$ (Fairfield Smith's law). The equation obtained was

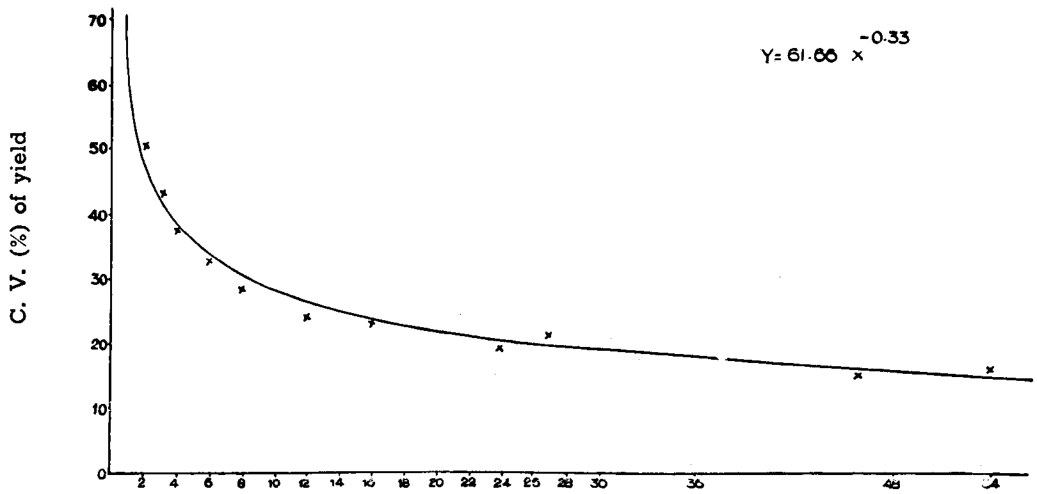
$$Y = 61.66\, x^{-0.332} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

with $R^2=0.98$. Fig. 1 shows the observed C. V. and the curve based on the above relationship. When the plot size exceeded eight there was no considerable reduction in the per unit decrease of C.V. and hence it was taken as the optimum

Table I. *Coefficient of variation for different plot sizes and shapes*

Columns	Rows								
	1	2	3	4	6	9	12	18	36
1	70.01	52.82	44.43	39.08	34.63	31.23	27.88	25.50	20.01
2	49.47	33.39	31.83	27.71	24.64	32.90	20.13	20.28	16.84
3	42.75	32.60	27.34	25.24	22.26	21.48	18.14	18.42	16.86
4	36.72	28.34	23.79	23.50	21.35	20.31	18.49	18.72	18.44
6	31.71	23.28	19.91	18.53	15.79	15.29	13.55	14.04	14.72
12	21.19	16.97	13.02	13.54	10.13	9.78	6.57	7.22	—

FIG. 1. REGRESSION OF DIFFERENT PLOT SIZES ON C. V. (%) OF THE YIELD IN CARDAMOM (FAIRFIELD SMITH LAW)



size. The C. V. of a plot with r rows and c columns was represented by the relationship.

$$Y = 63.10 \ r^{-0.460}c^{-0.272} \ldots\ldots\ldots\ldots\ldots (3)$$

with R^2=0.92. The row-wise heterogeneity was significantly higher than column-wise heterogeneity. As such formation of plots with more number of rows will give more homogeneous blocks for experiments.

Table II gives the minimum number of replications necessary for 10 per cent standard error, of treatment means and the ratio of borders to the experimental plants. The number of replications required decreased rapidly as the plot size increased. The ratio of borders to the experimental plants also reduced as the plot size increased, and hence the average cost due to border plants also decreased. The cost of experimentation per treatment under different price situations when the plots are arranged in blocks of 4, 6 and 12 for different sizes and shapes of plots based on the observed C. V. are presented in Table III. In some price situations corresponding to the minimum cost, more than one plot size and shape were observed. But in most of the cases with smaller block sizes a plot size of 12 plants arranged in four rows of three plants each was found to correspond to the minimum cost. But in 12 plot blocks a plot of size 6 × 3 was found to be optimum under price situation K_2, K_3 and K_4. In the case of K_1 the cost corresponding to plot size 6×3 was not the minimum which may be

Table II. *CV%, number of replications required for a given level of accuracy of the means and ratio of border to the experimental materials*

Shape of plot	Size of unit	4 plot block			6 plot block			12 plot block		
		CV%	r	B	CV%	r	B	CV%	r	B
1:1	1×1	67.11	45	5.75	66.70	45	5.50	67.20	46	5.25
	2×2	35.15	13	2.25	35.96	13	1.24	35.52	13	2.58
	3×3	23.95	6	1.36	25.15	7	1.31	25.24	7	1.27
1:2	1×2	51.94	27	3.88	51.23	27	3.92	51.11	27	3.63
	2×4	–	–	–	23.23	6	1.58	–	–	–
	3×6	20.71	5	1.01	19.81	4	0.99	23.13	5	0.97
1:3	1×3	39.92	16	3.25	39.92	16	3.17	41.07	17	3.08
	2×6	19.53	4	1.42	22.70	6	1.39	24.74	7	1.36
1:4	1×4	36.17	14	2.94	36.83	14	2.88	38.38	15	2.81
1:6	1×6	31.67	10	2.63	31.09	10	2.58	32.13	11	2.54
1:9	1×9	27.74	8	2.42	30.01	9	2.39	31.04	10	2.36
1:12	1×12	24.55	6	2.31	24.97	7	2.29	28.16	8	2.27
2:1	2×1	47.36	23	2.96	47.06	23	3.33	47.33	23	3.23
	4×2	–	–	–	24.11	6	1.38	–	–	–
	6×3	17.39	4	0.89	16.69	3	0.85	17.22	3	0.82
3:1	3×1	39.82	16	2.75	40.09	17	2.61	40.63	17	2.47
	6×2	22.03	5	1.17	23.01	6	1.11	23.31	6	1.06
4:1	4×1	32.75	11	2.38	32.96	11	2.25	33.55	12	2.13
6:1	6×1	29.83	9	2.00	30.26	10	1.89	30.25	10	1.78
	12×2	–	–	–	17.08	3	0.85	–	–	–
12:1	12×1	19.09	4	1.63	20.52	5	1.53	21.08	5	1.43
2:3	2×3	28.66	9	1.83	27.32	8	1.78	30.38	10	1.72
	4×6	–	–	–	22.74	6	0.79	–	–	–
3:2	3×2	31.07	10	1.71	31.36	10	1.64	31.25	10	1.57
	6×4	–	–	–	18.83	4	0.72	–	–	–
3:4	3×4	24.67	7	1.19	23.66	6	1.15	25.29	7	1.12
4:3	4×3	18.13	4	1.13	17.61	4	1.08	23.85	6	1.04
2:9	2×9	18.39	4	1.28	22.68	6	1.26	21.88	5	1.24

B = Ratio of borders to the experimental material

due to the sampling fluctuation of the variability. The number of rows were found to be more than the number of plants within a row for the optimum plots in different block sizes which was also confirmed by higher row-wise heterogeneity.

(equation $Y = 63.10\ r^{-0.460}\ c^{-0.272}$)
Hence a plot size of 12 plants arranged in four rows of three plants each for smaller blocks and 18 plants in six rows of three plants each for larger blocks can be taken as optimum.

Table III. *Cost of experimentation per treatment for different price situation in 4, 6 and 12 plot blocks*

Shape of plot	Size of plot	4 plot block				6 plot block				12 plot block			
		K_1	K_2	K_3	K_4	K_1	K_2	K_3	K_4	K_1	K_2	K_3	K_4
1:1	1×1	270	270	529	529	270	270	518	518	276	276	518	518
	2×2	234	156	351	273	234	156	347	269	234	156	368	290
	3×3	228	132	302	206	266	154	349	237	266	154	346	234
1:2	1×2	270	216	479	425	270	216	482	428	270	216	466	412
	3×6	370	200	461	291	296	160	367	231	370	200	457	287
1:3	1×3	224	160	380	316	224	160	376	312	238	170	395	327
	2×6	200	112	268	180	300	168	400	263	350	196	464	310
1:4	1×4	252	168	417	333	252	168	413	329	270	180	439	349
1:6	1×6	260	160	418	318	260	160	415	315	286	176	454	344
1:9	1×9	304	176	478	350	342	198	536	392	280	220	593	433
1:12	1×12	300	168	467	334	350	196	543	389	400	224	618	442
2:1	2×1	230	184	366	320	230	184	383	337	226	182	372	328
	6×3	296	160	360	224	222	120	268	166	220	120	264	164
3:1	3×1	224	160	356	292	238	170	371	303	238	170	364	296
	6×2	250	140	320	210	300	168	380	248	300	168	376	244
4:1	4×1	200	132	305	237	200	132	299	231	216	144	318	246
6:1	6×1	234	144	342	252	260	160	373	273	260	160	367	267
12:1	12×1	200	112	278	190	250	140	342	232	250	140	336	226
2:3	2×3	234	144	333	243	208	128	293	213	260	160	363	263
3:2	3×2	260	160	363	263	260	160	358	258	260	160	354	254
3:4	3×4	350	196	450	296	300	168	383	251	350	196	144	290
4:3	4×3	200	112	254	166	200	112	252	164	300	168	375	243
2:9	2×9	296	160	388	252	444	240	580	376	370	200	482	312

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