UNIFORMITY TRIALS: OPTIMUM SIZE AND SHAPE OF PLOTS AND BLOCKS IN EXPERIMENT WITH GINGER*

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ABSTRACT

Fairfield Smith's equation with standard notations $Y = ax^{-g}$ and its generalisation in the form $Y = ac^{-g_1} r^{-g_2}$ were fitted to the uniformity trial data on ginger conducted at Hirehalli during 1976–77 and 1977–78 where Y is the CV for the plot size x with r rows and c columns, taking the ultimate unit as (i) one row of 5 plants and (ii) number of plants in 1m × 1m bed. Row-wise heterogeneity was higher than column-wise heterogenity showing thereby that formation of plots with more rows will give more homogeneous blocks for experiments. The cost of experimentation per treatment to estimate the means at 5 per cent CV was worked out under different price situations. Plot size consisting of 3-4 rows of one column in the case of ultimate unit of plants in 1m × 1m bed, and plot size of 6 rows of one column in the case of ultimate unit of one row of 5 plants each, were found to be 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 maximum information from his experimental material. The size and shape of plots 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 the plot and block for which the plot to plot variation is minimum. Fairfield Smith (1938) worked out an empirical relationship between plot size and the CV for yield. Several earlier attempts have been made to determine the optimum size and shape of plots and blocks for various crops (Abraham *et al.*, 1969; Agarwal *et al.*, 1968;

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George *et al.*, 1979; and Shrikhande, 1958) but so far no such attempt has been made with regard to ginger plot size. In this paper, an attempt has been made to evaluate the optimum size and shape of plots in blocks, under different price situations.

Materials and Methods

Uniformity trials on ginger were laid out at CPCRI Research Centre, Hirehalli for 1976–77 and 1977–78 with 24 beds of size 1m×24m. During 1976–77, there were 4 rows of 120 plants each and during 1977–78, 5 rows of 120 plants each. Ultimate unit was taken as a row of 5 plants (this is considered as Case-1) and total weight of the produce was considered as the yield of the ultimate unit. This resulted in 96 rows of 24 units during 1976–77 and 120 rows of 24 units during 1977–78. Plots of varying sizes and shapes were formed combining adjacent units column-wise and row-wise, and the corresponding *CV* was worked out for both the years.

Later, the ultimate unit was altered to 1m×1m plot (this is considered as case-2) for both the years, so as to suit the normal practice of raising the crops in beds of 1m breadth by adding 4 rows of 5 plants each for the year 1976–77, and 5 rows of 5 plants each (5 units row-wise) for 1977–78. This resulted in 24 rows of 24 columns each for both the years which were again subjected to analysis.

Fairfield Smith's law $Y=ax^{-g}$ was fitted to find the relationship between plot size (x) and $CV(y)$, where g is the heterogeneity coefficient. Generalization of this law in the form $Y=ac^{-g_1} r^{-g_2}$ was also tried to compare the heterogeneity of rows and columns, where g's denote 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 5 per cent *CV* was worked out for four different price situations K_1, K_2, K_3 and K_4 using the relationship:

$$CK_i = C_1 r + C_2 E$$

where CK_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,

r is the number of replications and

E is the number of experimental plants.

The arbitrary cost ratios $C_1 : C_2$ for price situations K_1, K_2, K_3 and K_4 are 1 : 1, 2 : 1, 1 : 2 and 1 : 4, respectively.

Results and Discussion

In both the years and for both the cases under study, the *CV* decreased with an increase in plot size in both the directions. Decrease was more rapid in row-wise direction. The *CV* values determined for various size and shape of plots followed closely the relation $Y = ax^{-g}$. The equations along with its R^2 values for both the cases and for both the years are presented in Table 1. In both the years, no appreciable reduction of per unit decrease in *CV* was noticed, when the plot size exceeded 4 in case–2, and 6 in case–1. Hence, plot sizes of 4 and 6 were taken as optimum, for case 2 and case 1, respectively.

Table 1. Fairfield Smith's law $Y = ax^{-g}$

Year	Case 1	Case 2
1976–77	$Y = 56.48x^{-0.30}$ ($R^2 = 0.98$)	$Y = 33.75x^{-0.22}$ ($R^2 = 0.97$)
1977–78	$Y = 73.19x^{-0.17}$ ($R^2 = 0.96$)	$Y = 57.37x^{-0.19}$ ($R^2 = 0.96$)

Table 2. Fairfield Smith's Generalized relationship $Y = ac^{g1} r^{g2}$

Year	Case 1	Case 2
1976–77	$46.54c^{-0.21}\ r^{-0.24}$ ($R^2 = 0.92$)	$31.32c^{-0.18}\ r^{-0.19}$ ($R^2 = 0.88$)
1977–78	$78.23c^{-0.17}\ r^{-0.23}$ ($R^2 = 0.89$)	$63.66c^{-0.14}\ r^{-0.32}$ ($R^2 = 0.92$)

Case 1. One row of 5 plants

Case 2. Plants in 1m×1m bed

Y is the *CV* for the plot size *x* with *r* rows and *c* columns.

The generalized Fairfield Smith's Law represented in the form: $Y = ac^{-g_1} r^{-g_2}$ was a satisfactory fit for both the years and both the cases under study. The equation along with its R^2 values are given in Table 2. The row-wise heterogeneity was significantly higher than column-wise heterogeneity, thereby suggesting that formation of plots with more number of rows will give more homogeneous blocks for experiments.

The relative cost of experimentation per treatment under 4 different price situations when the plots are arranged in blocks of 4, 6, 8 and 12 for different sizes and shapes of plots based on the observed *CV*, was worked out for 1976–77 and 1977–78 and for

Table 3. Cost of experimentation per treatment for different price situations in 4-and 12-plot blocks. Case-1: Ultimate unit 1 row of 5 plants (1976–77)

Shape of Plot	Size of Plot	4 plot						12 Plot					
		C.V.	r	K_1	K_2	K_3	K_4	C.V.	r	K_1	K_2	K_3	K_4
1:1	1×1	56.60	123	256	384	384	640	57.51	132	264	396	396	660
	2×2	57.81	134	670	804	1206	2278	31.76	40	200	240	360	680
1:2	1×2	42.90	74	222	296	370	666	43.65	76	228	304	380	684
	2×4	23.65	22	198	220	374	726	24.42	24	216	240	408	792
1:3	1×3	36.27	53	212	265	371	689	36.96	55	220	275	385	715
	2×6	20.96	18	234	252	450	882	21.55	19	247	266	475	931
1:4	1×4	31.83	41	205	246	369	697	33.26	44	220	264	396	748
1:6	1×6	28.61	33	231	264	429	825	28.37	32	224	256	416	800
1:8	1×8	24.56	24	216	240	408	792	25.77	27	243	270	459	891
1:12	1×12	23.66	22	286	308	550	1078	22.38	20	260	280	500	980
2:1	2×1	89.21	61	183	244	305	549	40.25	65	195	260	325	585
	4×2	23.56	22	198	220	374	726	23.54	22	198	220	374	726
3:1	3×1	34.20	47	188	235	329	611	35.01	49	196	245	343	637
	6×2	20.39	17	221	238	425	833	20.91	17	221	238	425	833
4:1	4×1	25.39	26	182	208	338	650	26.00	27	189	216	351	675
6:1	6×1	29.30	34	170	204	306	578	29.71	35	175	210	315	595
8:1	8×1	23.38	22	198	220	374	726	22.44	20	180	200	340	660
12:1	12×1	20.20	16	208	224	400	784	20.40	17	221	238	425	833
2:3	2×3	25.69	26	182	208	338	650	26.97	29	203	232	377	725
3:2	3×2	26.92	29	203	232	377	725	27.39	30	210	240	390	750
3:4	3×4	20.52	17	221	238	425	833	21.92	19	247	266	475	931
4:3	4×3	18.93	14	182	196	350	686	20.00	16	208	224	400	784

Table 4. Cost of experimentation per treatment for different price situations in 4-and 12 plot blocks Case-2: Ultimate unit 1m×1m plot (1976–77)

Shape of Plot	Size of Plot	4 Plot						12 Plot					
		C.V.	*r*	K_1	K_2	K_3	K_4	C.V.	*r*	K_1	K_2	K_3	K_4
1:1	1×1	31.73	40	80	120	120	200	33.29	44	88	132	132	220
	2×2	32.45	42	210	252	378	714	21.94	19	95	114	171	323
1:2	1×2	25.58	26	78	104	130	234	27.26	30	90	120	150	270
	2×4	25.25	26	234	260	442	858	18.24	13	117	130	221	429
1:3	1×3	21.80	19	76	95	133	247	21.95	18	72	90	126	234
	2×6	14.74	9	117	126	225	441	15.77	10	130	140	250	490
1:4	1×4	17.58	12	60	72	108	204	20.26	16	80	96	144	272
1:6	1×6	15.77	10	70	80	130	250	17.55	12	84	96	156	300
1:8	1×8	11.94	6	54	60	102	198	15.63	10	90	100	170	330
1:12	1×12	12.39	6	78	84	150	294	12.16	6	78	84	150	294
2:1	2×1	23.69	22	66	88	110	198	25.39	26	78	104	130	234
	4×2	14.75	9	81	90	153	297	17.49	12	108	120	204	396
3:1	3×1	10.38	4	36	40	68	132	12.77	7	63	70	119	231
4:1	4×1	16.13	10	50	60	90	170	18.30	13	65	78	117	221
6:1	6×1	14.90	9	63	72	117	225	16.95	11	77	88	148	275
8:1	8×1	20.26	16	64	80	112	208	21.76	19	76	95	133	247
12:1	12×1	10.91	5	65	70	125	245	12.79	7	91	98	175	343
2:3	2×3	18.14	13	91	104	169	325	17.66	12	84	96	156	300
3:2	3×2	17.27	12	84	96	156	300	19.38	15	105	120	195	375
3:4	3×4	11.60	5	65	70	125	245	14.62	9	117	126	225	441
4:3	4×3	14.00	8	104	112	200	392	13.91	8	104	112	200	392

both the cases. Tables 3 and 4 give the relative cost of experimentation for blocks of sizes 4 and 12 for 1976–77 foı case-1 and case-2, respectively. The number of replications decreased rapidly as the plot size increased. A close study of the analysis reveals (Table 3) that plots of 6 rows of one column each gave the minimum cost for 1976-77 for case-1. The subsequent year's data undoubtedly confirmed this result. The plot size obtained by the graphical method also confirmed this result. In case-2 where the ultimate unit is 1m×1m, 3 rows of one column each were found to be optimum for block sizes 4, 6 and 8 plots and 4 rows of one column each for 12-plot block (Table 4). Hence, plot size of 6 rows of one column in the case of ultimate unit of one row of 5 plants each, and 3-4 rows of one column, in the case of ultimate unit of plants in 1m×1m bed, were found to be optimum.

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DISCUSSION

V. S. SHARMA (UPASI, Cinchona): Do you think it is necessary to study the interaction between the cultivar used and the plot size because tillering and the number of fingers may interact with the spacing and plot size?

BHAGAVAN: Yes, it will be a really interesting study to know the interaction between cultivars and the plot size. If interaction is found to exist, one may have to go in for different plot sizes for different groups of cultivars.