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UNIFORMITY TRIALS : OPTIMUM SIZE AND SHAPE OF PLOTS AND BLOCKS IN EXPERIMENTS WITH CASHEW*

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ABSTRACT

Uniformity trials in cashew (airlayers) were laid out in the existing cashew estates at Periya, Kasaragod district, belonging to the Plantation Corporation of Kerala. The yield data from 288 trees (24 rows of 12 trees each) were collected for two years 1982-83 and 1983-84 by daily harvest. Fair field Smith's Law $Y = ax^{-g}$ and its generalisation $Y = ac^{-g1} r^{-g2}$ where g's stand for the heterogeneity coefficients expressing the relationship between plot size (x) in r rows of c column and the C. V. (Y) of yield were tried Graphical method and maximum curvature technique were used for working out the optimum plot size. Further the cost of experimentation per treatment to estimate the means at 10% S. E. was worked out for different price situations. A plot size of 6 rows of 2 trees each forming the plot across the fertility lines was found to be the optimum for experiments with cashew.

INTRODUCTION

In agriculture research, the importance of size and shape of plots and blocks for efficient planning of field experiments is widely known. The size and shape of plots depends on the inherent variability present in the crop and the environment in which it is grown. Fair field Smith (1938) worked out an empirical relationship between plot size and the C. V. % of yield. Several attempts have been made to determine the optimum size and shape of plots and blocks for various plantation crops. Agarwal, Bavappa and Khosla (1968), Abraham, Khosla and Agarwal (1969), George, Sannamarappa and Bhagawan (1979), George et al., (1983), George et al. (1989), George and Sannamarappa, (1984) have worked out the optimum plot size for arecanut, pepper, turmeric, cardamom, ginger and turmeric respectively. In this paper an attempt has been made to evaluate the optimum size and shape of plots and blocks under different price situations for cashew which is an important cash crop producing about 2.2 million tonnes of kernels and earning about Rs. 215 crores of foreign exchange annually.

MATERIALS AND METHODS

Uniformity trials in cashew (airlayers) were laid out in the existing cashew estates at Peria belonging to the plantation Corporation of Kerala, with 24 rows of 12 trees each at a spacing 8 m x 8 m. The yield data of individual trees were collected by daily harvest for two years 1982–83 and 1983–84. Ultimate unit was taken as the yield of individual trees and plots of varying sizes and shapes were formed, combining adjacent units column wise and row-wise and corresponding C. V. % was worked out for both the years.

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Fairfield Smiths Law $Y = ax^{-g}$ was fitted to find out the relationship between plot size (x) and C. V. (Y) where g is the soil heterogeneity coefficient. Generalisation of the law in the form $Y = ac^{-g1}, r^{-g2}$ was also tried to compare the heterogeneity between rows and columns where g's stand for the corresponding coefficients.

Method of maximum curvature was also tried for getting the optimum plot size. The optimum plot size (x) is that value of the size of the plot which lies just beyond the point of maximum curvature. The curvature of any curve at a given point is defined by $C = \frac{Y_2}{(1+Y_1^2)^{3/2}}$ where Y_1 and Y_2 are the first and second derivatives of the functional form (Y) of the curve. The point at which the curve attains the maximal value is obtained by differentiating the expression for the curvature and setting $\frac{dc}{dx}$ to zero. For Smiths' function the resultant equation is $X^{2(g+1)} = \frac{(ag)^2(2g+1)}{g+2}$

The plot size and shape giving the required information at a minimum cost was taken as optimum. The cost of experimentation per treatment to estimate the means at 10% C. V. was worked out under different price situations K_1, K_2, K_3 and K_4 using the relationship $c_{ki} = C_1.r + C_2.E + C_3.B$ where

C_{ki} is the cost of the ith price situation

C_1 the cost of maintaining the 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 the price situations K_1 and K_2 (without borders) and K_3 and K_4 (with borders) are 1:4:0; 1:8:0; 1:4:1 and 1:8:1 respectively.

RESULTS AND DISCUSSION

The CV decreased with the increase in plot size in both the directions but the reduction was little more rapid row-wise for the year 1982–83. The CV averaged over the different shapes of plots followed closely the relationship $Y = a x^{-g}$. The equations obtained were $Y = 91.82 \times ^{0.51}$ ($R^2 = 0.98$) for 1982–83 and $Y = 93.96 \times ^{-0.50}$ ($R^2 = 0.98$) for 1983–84.

The Smith's index of soil heterogeneity found around 0.5 was indicative of the high variability of cashew crop as well as the heterogeneity, of the soil. The CV of the plot with r rows and c columns were represented by the relationship

$Y = 90.29\ C^{-0.54}\ r^{-0.46}$ ($R^2 = 0.94$) for 1982–83 and

$Y = 96.03\ C^{-0.59}\ r^{-0.43}$ ($R^2 = 0.96$) for 1983–84.

The maximum curvatures were found at X = 11.9 and 12.1 respectively, showing that 12 was the optimum plot size.

Tables I and II showed the minimum number of replications necessary for 10% SE of treatment means and the relative cost of experimentation for blocks of sizes 4 and 12 for 1982–83 and 83–84 respectively. The number of replications decreased rapidly as the plot size increased. A close study of analysis revealed (Table II) that a plot size of 12 *i.e.*, 6 rows of two trees each or 12 trees in a row was found to have the minimum cost for smaller as well as larger number of treatments. In Table I the plot sizes 6 x 2 and 3 x 4 gave the minimum cost with regard to the blocks with larger

Table I. *Relative cost of experimentation per treatment for different price situations in 4 and 12 plot blocks – cashew 1982*

Size	4 plot blocks						12 plot blocks					
	C. V.	r	K1	K2	K3	K4	C. V.	r	K1	K2	K3	K4
1 x 1	90.80	82	1394	2706	2706	4018	91.87	84	4116	8148	8148	12180
2 x 2	49.65	25	1625	3225	2225	3825	48.70	24	4632	9240	6360	10968
3 x 3	32.48	11	1595	3179	1947	3531	0.00	0	0	0	0	0
1 x 2	62.26	39	1287	2535	2067	3315	64.71	42	4074	8106	6594	10626
2 x 4	36.32	13	1677	3341	2093	3757	36.06	13	5005	9997	6253	11245
1 x 3	55.47	31	1519	3007	2263	3751	54.12	29	4205	8381	6293	10469
2 x 6	27.23	7	1351	2695	1631	2975	26.00	7	4039	8071	4879	8911
1 x 4	47.28	22	1430	2838	2046	3454	46.67	22	4246	8470	6094	10318
1 x 6	33.24	11	1067	2123	1463	2519	33.04	11	3179	6347	4367	7535
1 x 12	24.35	6	1158	2310	1518	2670	23.93	6	3462	6918	4542	7998
2 x 1	66.06	44	1452	2860	2332	3740	67.72	46	4462	8878	7222	11638
2 x 3	45.23	20	1940	3860	2500	4420	42.26	18	5202	10386	6714	11898
3 x 1	52.35	27	1323	2619	1971	3267	51.19	26	3770	7514	5642	9386
6 x 2	24.09	6	1158	2310	1398	2550	23.15	5	2885	5765	3485	6365
3 x 2	36.92	14	1358	2702	1750	3094	34.93	12	3468	6924	4476	7932
4 x 1	45.75	21	1365	2709	1953	3297	44.50	21	4053	8085	5817	9849
4 x 2	29.97	9	1161	2313	1449	2601	30.92	10	3850	7690	4810	8650
3 x 4	24.17	6	1158	2310	1374	2526	23.22	5	2885	5765	3425	6305
4 x 3	27.21	7	1351	2695	1603	2947	26.33	7	4039	8071	4795	8827
6 x 1	39.59	16	1552	3088	2128	3664	37.25	14	4046	8078	5558	9590
8 x 1	31.30	10	1290	2570	1730	3010	31.99	10	3850	7690	5170	9010
12 x 1	24.52	6	1158	2310	1518	2670	23.51	6	3462	6918	4542	7998

number of treatments. This also confirmed the results that the optimum plot was around 12 by the method of maximum curvature and about 12 trees by the graphical method. However, in smaller blocks the plot size of 1 x 6 was found to have the minimum cost. But the number of replications required was 10 to 12 whereas for the 6 x 2 plot the number of replications required was only 5 or 6. As such there was no advantage for the smaller plot of 6 x 1 instead of 6 x 2. Hence for a plot size of 6 rows of 2 trees each could be taken as optimum. Further there was no significant reduction in CV in any direction when compared to the other. It indicated that the shape of the plot was not of much importance except that the

Table II. *Relative cost of experimentation per treatment for different price situations in 4 and 12 plot blocks – cashew* 1983

Size	4 plot block						12 plot block					
	C. V.	r	K1	K2	K3	K4	C. V.	r	K1	K2	K3	K4
1 x 1	88.76	79	1343	2607	2607	3871	88.23	78	3822	7566	7566	11310
2 x 2	46.23	21	1365	2709	1869	3213	48.41	23	4439	8855	6095	10511
3 x 3	35.70	13	1885	3757	2301	4173	0.00	0	0	0	0	0
1 x 2	62.93	40	1320	2600	2120	3400	63.45	40	3880	7720	6280	10120
2 x 4	34.59	12	1548	3084	1932	3468	34.73	12	4620	9228	5772	10380
1 x 3	49.84	25	1225	2425	1825	3025	54.88	30	4350	8670	6510	10830
2 x 6	26.92	7	1351	2695	1631	2975	28.22	8	4616	9224	5576	10184
1 x 4	43.88	19	1235	2451	1767	2983	43.82	19	3667	7315	5263	8911
1 x 6	31.86	10	970	1930	1330	2290	35.04	12	3468	6924	4764	8220
1 x 12	27.02	7	1351	2695	1771	3115	31.21	10	5770	11530	7570	13330
2 x 1	61.25	38	1254	2470	2014	3230	62.10	39	3783	7527	6123	9867
2 x 3	40.53	16	1552	3088	2000	3536	44.70	20	5780	11540	7460	13220
3 x 1	52.01	27	1323	2619	1971	3267	49.81	25	3625	7225	5425	9025
6 x 2	23.24	5	965	1925	1165	2125	22.56	5	2885	5765	3485	6365
3 x 2	38.67	15	1455	2895	1875	3315	37.44	14	4046	8078	5222	9254
4 x 1	50.85	26	1690	3354	2418	4082	50.83	26	5018	10010	7202	12194
4 x 2	31.08	10	1290	2570	1610	2890	31.90	10	3850	7690	4810	8650
3 x 4	26.67	7	1351	2695	1603	2947	25.45	6	3462	6918	4110	7566
4 x 3	31.18	10	1930	3850	2290	4210	34.23	12	6924	13836	8220	15132
6 x 1	33.61	11	1067	2123	1463	2519	34.08	12	3468	6924	4764	8220
8 x 1	29.56	9	1161	2313	1557	2709	30.69	9	3465	6921	4653	8109
12 x 1	22.76	5	965	1925	1265	2225	22.13	5	2885	5765	3785	6665

length of the plot should be across the fertility line so that the variability between plots is reduced to the minimum. Hence a plot size of 6 rows of 2 trees each forming the plots across the fertility line would be taken as the optimum plot size for experiments with cashew.

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