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RELATIVE EFFICIENCY OF PLOTS AND BLOCKS FOR FIELD EXPERIMENTS IN 8RINJAL

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In agricultural experiments, the experimenter is interested to ascertain, the relative worth of a set of treatments with reasonable confidence. To achieve this objective, the efficiency of experimental design is improved by adopting the principles of randomisation, replication and focal control. Besides these, the accuracy of the estimates depends on the size and shape of the experimenal plots. Complex designs with their plots and blocks are also evolved mainly to control variations due to soil heterogeneity in field experiments. But regardless of their complexity, these designs vary in their utility and efficiency. Though, the choice of a particular design is often affected by many pragmatic consideration evolved in field conditions, a knowledge about their relative efficiencies often helps in making such choices **in** many occasions (Jayaraman, 1 979). It has been observed that block size used in a design is an important factor in determining its relative efficiency. Therefore, for efficient planning, the information on efficiency of different block sizes is also of great importance. Although studies of this kind were carried out in part by Hutchinson and Panse (1935) on cotton and Abraham and Vachhani (1964) and Agarwal and Deshpande (1967) on paddy no such information on plot and block size efficiency is available in literature on brinjal, one of the most commonly used vegetables in Kerala.

Materials and Methods

A uniformity trial was conducted at the main campus of Kerala Agricultural University, Vellanikkara during the third crop season 1980, using the brinjal variety SM 6. The crop was planted in north south direction with a row to row spacing of 60 cm and plant to plant distance of 45 cm. The trial consisted of 68 rows each comprising of 64 plants. Harvesting of crop was done in small units of four plants, the size of unit being 1.2 m x 0.9 m. Thus the units are arranged in 32 rows each consisting of 30 units excluding two border rows. The number and weight of fruit for each unit were recorded separately in each harvest. For the purpose of the study, yield per unit, number of fruits per unit, height, number of primary branches were consiaered.

The coefficient of variation (CV) was averaged over different shapes of blocks for a fixed size. If x is the number of basic units constituting a plot,

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efficiency of a plot was worked using the formula $1/(x.cv_x)$ (Kalamkar, 1932). For working out the relative efficiency (RE) of various block sizes, the ratio of error variance of a particular block arrangement was worked out. This ratio was expressed as percentage and was taken as the efficiency of block arrangement.

Agarwal *et al.* (1968) suggested another method for working out RE of various plot sizes. If v_1 and v_2 are the variances of two plot sizes, a_1 and a_2 are the plot sizes expressed on a per unit bais, r_1 and r_2 are the number of replications, RE of the plot size a_2 compared with a, is given by $(v_1.r_2)/v_2.r_1)$. The CV is proportional to $(v/a)^{\frac{1}{2}}$. Therefore (v_1/v_2) can be replaced by $(a_1/a_2)/cv_2/cv_1)^2$. Again the total area of the field is fixed. Then $a_1r_1=a_2r_2$. Finally $(v_1.r_2)/v_2.r_2)$ can be replaced by $(a_1/a_3)^2$. $(c_1v/cv_2)^2$, cv_1 is the cv for plot size a_1 and cv_2 is the cv for plot size a_2 and cv_2 is the cv for plot size a_2.

The efficiency of blocks is closely linked with the number of replications. Hence for a particular block size and shape, it is necessary to know the number of replications required to obtain 5% of error of the mean. It was arrived at, by using the formula $r = (cv/p)$. The cv is the average cv and p is the 5 per cent standard error (SE) of mean. The total area required for experimentation was obtained by multiplying the plot size (m^2) with number of replication at 5 per cent SE of the mean for different sizes of the blocks and plot.

Results and Discussion

Efficiency of different plots is presented in Table 1. It decreased as the size of the plot was increased and it ranged from 0.0265 to 0.0022. This decrease in the efficiency of bigger plot implies that higher variability can be counter balanced by using smaller plots. When the plot size is increased, the soil differences are averaged out but this introduces more error due to larger variation within blocks.

Taking efficiency of small plot as unity, the RE of various plot sizes are given in Table 2. It was found that RE decreased from 1.0 to 0.048 as the size of the plot was increased from 2.16 m^2 to 25.92 m^2. The efficiency was the highest for the smallest plot. So the objective should be to decrease the plot size as far as possible subject to practical consideration and to increase number of replication proportionally.

To study the variability in block, the plots of different sizes and shapes were grouped together in blocks of 2, 4, 6, 8 and 12 plots. The arrangement of plots within blocks is as given in Table 3. For the yield data, in the case of 2 plot blocks, the most efficient plot size is 12 followed by plot size 8. Similar results can be drawn for 4, 6, 8 and 12 plot blocks. In general, we could conclude that all types of blocks, plot sizes of 8 and 12 were found to be most efficient. The data on number of fruits per plant, number of primary branches and height of the plant are also resorted to the above arrangement (Table 3). On a careful observation a plot size 8 was found to be the most efficient for these three characters.

Table 1

CV and the efficiency of a plot

Plot size	Without blocking	2 plot blocks	4 plot blocks	6 plot blocks	a plot blocks	12 plot blocks
2	50.66 (0.0099)	36 94 (0.0135)	30.31 (0.0165)	24.08 (0.0208)	23.14 (0.0216)	18.87 (0.0265)
3	44.38 (0.0075)	32.54 (0.0102)	23.78 (0.0140)	22.88 (0.0146)	18.00 (0.0185)	16.14 (0.0207)
4	39.49 (0.0063)	30.31 (0.0082)	23.74 (0.0105)	20.18 (0,0124)	18.91 (0.0132)	14.09 (0.0177)
6	33.12 (0.0050)	24.80 (O.OC67)	18.87 (0.0088)	20.02 (0.0083)	15.98 (0,0104)	13.09 (0.0127)
8	29.64 (0.0042)	24.89 (0.0050)	18.91 (0.0066)	20.14 (0,0063)	12.89 (0.0097)	9.63 (0.0127)
12	23.58 (0.0035)	18.37 (0.0045)	14.26 (0.0058)	13,29 (0.0063)	9.17 (0.0091)	8.62 (0.0097)
24	19,20 (0.0022)	14.65 (0.0028)	9.86 (0.0042)	9.59 (0.0043)	4.70 (0.0089)	4.54 (0.0092)

(Efficiencies are given in paranthesis)

Table 2

Plot size, CV and relative efficiency

Plot size	Without blocking	2 plot blocks	4 plot blocks	6 plot blocks	8 plot blocks	12 plot blocks
2.16	50.66 (1.000)	36.94 (1.000)	30.31 (1.000)	24.08 (1.000)	23.14 (1.000)	18.87 (1.000)
3.24	44.38 (0.579)	32.54 (0.881)	23.78 (0.785)	22.88 (0.950)	18.00 (0.778)	16.14 (0.697)
4.32	39.49 (0.414)	30.31 (0.821)	23.74 (0.783)	20.18 (0.838)	18.91 (0.817)	14.09 (0.609)
6.48	33.12 (0.260)	24.80 (0.671)	18.87 (0.623)	20.02 (0.831)	15.98 (0.691)	13.09 (0.566)
12.96	23.58 (0.128)	18.37 (0.497)	14.26 (0.470)	13.29 (0.552)	9.17 (0.396)	8.62 (0.373)
25.92	19.20 (0.048)	14.65 (0.397)	9.86 (0.325)	9.69 (0.398)	4.70 (0.203)	4.55 (0.196)

(Relative efficiency is given in parenthesis)

Table 3

Block efficiency (%) for various characters

Character	Plot size (m²)	2 plot blocks	4 plot blocks	6 plot blocks	8 plot blocks	12 plot blocks
	1 C8	86.85	76.37	74.46	64.25	53.84
	2.16	88.92	79.31	68.99	70.89	61.06
Yield	4.32	90.02	81.10	75.85	75.56	66.08
	6.48	89.58	79,30	75.69	75.45	69.45
	8.64	90.96	81.22	78.66	77.64	69.37
	12.96	90.63	79.28	77.60	76.51	75,08
	1.08	84.13	74.19	72.18	63.14	52.43
	2.16	88.91	80.06	72.08	71.11	60.94
Fruits/plant	4.32	90.59	83.97	75.22	74.12	73.23
	6.48	89.12	79.75	78.60	73.95	59.48
	8.64	92.67	84.83	82.06	81.06	67.40
	12.96	91.63	82.29	66.59	76.79	69.81
	1.08	86.57	80.34	78.68	72.91	60,92
	2.16	93.22	87.17	79.64	72.68	69.57
Primarybranches	4.32	93.84	89.44	80.49	75.70	73.01
	6.48	91.92	84.00	81.38	80.79	74.66
	8.64	89.92	89.77	82.41	84.27	76.47
	12.96	86.50	82.97	79.66	74.55	73.68
	1.08	85.49	75.28	73.32	63.70	53.14
	2.16	88.92	79.69	70,54	71.00	61.00
Height of the plant	4.32	90.31	82.54	75.54	74.84	69.66
	6.48	89.35	79.53	77.15	74.70	64.47
	8.64	91.82	83.03	80.36	79.35	72.72
	12.96	91.13	82.79	78.10	72.72	72.45

Minimum number of replication

The reduction in experimental error for treatment comparison can be acheived by (i) taking larger plots and {ii) increasing the number of replication (Agarwal *et al.*, 1968). The two criteria are complementary for a fixed experimental area. Hence a plot size which achieves a balance between these two criteria is defined as optimum plot. (Harris, 1915} recommended that increasing replication would decrease the SE more rapidly than increasing the size of plots. Therefore the number of replications necessary for a given standard of accuracy was studied. The effective number of replication and total area required per treatment were worked out for various plot size (Table 4).

Table 4

Minimum number of replications and minimum area required at 5% of the mean

No. of plots	Plot size	Without blocking		2 plot blocks		4 plot blocks		6 plot blocks		8 plot blocks		12 plot blocks	
	a	r	a	r	a	r	a	r	a	r	a	r	a
2	2.16	103	222.48	55	118.80	37	79.92	23	49.68	21	45.36	14	30.24
3	3.24	79	255.96	42	136.08	23	74.52	21	68.04	13	42.12	10	32.40
4	4.32	62	267.84	37	159.84	23	99.36	16	69.12	14	60.48	8	34.56
6	6,48	44	285.12	25	162.00	14	90.72	16	103.68	10	64.80	7	45.36
3	8.64	35	302,40	22	190.08	14	120.96	16	138,24	8	69.12	6	51.84
12	12.96	22	285.12	14	181.44	8	103.68	7	90.72	4	51.84	3	38,88
24	25.92	15	388.80	9	233.28	4	103.68	5	129.60	4	103.68	4	103.68

a = Area in sq m
r = Number of replication

For smaller plots, a fairly large number of replications were required to achieve 5 per cent accuracy in any of the block sizes. But as the plot size was increased from 2.16 m- to 25.92 m^2, there was considerable reduction in the number of replications required to obtain the same precision. For instance, for plots of size 12.9 m- in blocks of 4 plots or 8 plots, only 8 or 4 replications respectively were needed whereas for plots of size 2.16 m-, 37 or 21 replications were required. But the total area required by smaller plots was much than that by bigger plots. It is therefore better to have smaller plots with more replications.

Since the number of replications required to achieve 5 per cent accuracy, is directly proportional to the square of variation, a decrease in the cv implies a decrease in the number of replications. Hence, less replications are required if, bigger plots are used and vice versa. To achiev3 'p' per cent accuracy, the number of replications should be mutliplied by the factor $(5/p)^2$.

Summary

For field experiments with brinjal, taking the efficiency of the smallest plot as unity, RE values of various plots were computed. The efficiency was the highest for the smallest plot.

There is a genera! decrease of block efficiency with increasing block size. More compact block of the same size shows higher efficiency. Blocks of identical size and shape, but consisting of long plots also show a some what higher efficiency than bloks with short plots of the same size. Arrangement of plots in more than one row decreased block efficiency and the effect is more pronounced with long plots.

The number of replication required for a given level of accuracy decreased with an increase in plot size and increasing the number of replication rather than plot size was found more advantageous for a fixed experimental area.

സംഗ്രഹം

ചെറിയ ഏകകങ്ങളുടെ ക്ഷമത ഏകമാക്കിക്കൊണ്ട് പല ഏകകങ്ങളുടെ reraj(ia_t ക്ഷിക ക്ഷമത കണ്ടുപിടിച്ചു. ചെറിയ ഏകകങ്ങൾക്ക് കൂടുതൽ ക്ഷമതയുണ്ടെന്ന് അനുമാനിക്കാം. അതുകൊണ്ട് ഏകകപരിമാണം കുറക്കുകയും പുനരാവൃത്തികളുടെ എണ്ണം ഉയർത്തുകയുമാകണം ഉദ്ദേശം. പല ഖണ്ഡപരിമാണങ്ങളുടെ ആപേക്ഷിക ക്ഷമത കണ്ടുപിടിക്കുവാൻ ഒരു പ്രത്യേക ഖണ്ഡ വിന്യാസത്തിന്റെയും ഖണ്ഡവിന്യാസം ഇല്ലാത്തതിന്റെയും ത്രുടിവ്യതിയാനത്തിന്റെ അനുപാതം ശതമാനത്തിൽ പ്രയോഗിച്ചു. ഖണ്ഡപരിമാണം കൂടുമ്പോൾ flj ണ്ഡക്ഷമത കുറയുന്നു. ഒരേ പരിണാമമുള്ള നിബിഡഖണ്ഡങ്ങൾ കൂടുതൽ ക്ഷമത കാണിക്കുന്നു. ഒരേ രൂപത്തിലും പരിമാണത്തിലുമുള്ള ഖണ്ഡകങ്ങളിൽ ഒരേ പരിമാണത്തിലുള്ള നീളം കുറഞ്ഞ ഏകകങ്ങൾ നീളം കൂടിയവയേക്കാൾ ക്ഷമത കാണിക്കുന്നു. ഓരോ സംപ്രയോഗത്തിനും അഞ്ചു ശതമാനം പ്രമാണപിശകിനടിസ്ഥാനമാക്കി വ്യത്യസ്ത ഏകക പരിമാണങ്ങൾക്ക് ഏറ്റവും കുറഞ്ഞ പുനരാവൃത്തികളുടെഎണ്ണവും ക്ഷേത്രഫലവും കണക്കാക്കിയിട്ടുണ്ട്.

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