GAU Res. J. 1994. 19 (2) : 92-97

Optimum Plot Size for Summer Paddy in the Navsari Zone of Gujarat

S. M. Upadhyay*, B. H. Prajapati, K. R. V. Raja and V. B. Darji

Department of Agril. Statistics, College of Agriculture, Gujarat Agricultural University, Junagadh

ABSTRACT

Optimum plot size and shape of plot has been worked out from uniformity trial on summer paddy crop. Maximum curvature method, Fair-field Smith's verlance law and the comparable variance method were used for the purpose. A plot of 12 units i.e. 10 rows each of 6.3 meter length (i.e. 2 m. x 6.3 m. was found optimum for paddy variety I.R.8 grown at Navsari zone of Gujarat State.

(Received on 4th Aug., 1990)

INTRODUCTION

One of the important factors which has direct impact on the efficiency of the field experimentation in the size and shape of experimental plot, which varies with the crops. The other factors affecting the precision of the experimental result are experimental material, cost of various operations and material involved in conducting the experiment. Several workers have worked with the methodology for determining optimum plot size from uniformity trial data (Smith, 1938; Keller, 1949; Koch and Rigney, 1951; Federer, 1955; Hatheway and Williams, 1958 and Patel and Patel 1968). While Abraham and Vachhani (1964) and Agrawal and Deshpande (1967) reported optimum plot size for paddy crop. However, there is no report on optimum plot size for paddy for South Gujarat, being predominantly paddy growing area. This paper reports the results of uniformity trial on paddy conducted at the Agronomy Farm, N. M. College of Agriculture, Gujarat Agricultural University, Navsari Campus, Navsari during the summer season of the year 1982.

MATERIALS AND METHODS

The popular variety I.R. 8 was planted in a field of 26 m x 23 m size. Three seedling per hill was transplanted. The spacing was 20 cm between rows and 15 cm between two dibbles within row. All the recommended practices in vogue were followed. The crop was harvested in small units each of 35 hills (5 row each having 7 hills), the size of the basic unit being 1 m x 1.05 m. Border area of one meter width all around was excluded from the trial. Thus total area harvested was 24 m x 21 m making 480 basic units under study. Grain yield of paddy was recorded seperately for each basic unit. The different sized plots of sizes 1, 2, 4, 5, 6, 8, 10, 12, 16, 20, 24 and 30 units were

*Present Address : Assistant Research Scientist (Ag. Stat.), E.C.F., Project, GAU, Sardar Krushinagar.

formed by combining the adjacent units both length wise as well as width wise.

Statistical analysis

Maximum curvature method (Federer, 1955). Smith's variance law (Smith, 1938) and comparable variance method (Keller, 1949) were employed to investigate the optimum plot size and shape for summer paddy (Cv. IR 8).

Maximum curvature method involves plotting a curve of the C. V. per cent per unit area against plot size. Therefore C. V. per cent per unit area was estimated for various sized plots. These C. V. per cent are termed as unadjusted C. V. per cent.

Soil heterogeneity index 'b' was also estimated for determining optimum plot size with the help of an emperical relation between plot variance and size, developed by Smith (1938) as under :

$$Vx = V_1 / X^b$$

The estimated 'b' indicates the degree of correlation among the adjacent units. It was therefore, thought worthwhile to work out C. V. per cent after adjusting variance per unit area for degree of correlation 'b' among adjacent units to help workout optimum plot size based on uncorrelated estimates. These C. V. per cent are termed as adjusted C. V. per cent.

RESULTS AND DISCUSSION

The C. V. per cent was worked out and comparison were made among different sizes and shapes of plots using adjusted and unadjusted C. V. per cent.

TABLE 1

Average C. V. per cent per unit size for grain yield of paddy.

Size of plot	*C. V. per cent (unadjusted)*	*Difference in C. V. per cent (unadjusted)*	*Per unit decrease in CV % (unadjusted)*	*C.V. per cent (adjusted)*
1	20.69	–	–	20.69
2	17.71	2.98	2.98	18.23
4	15.40	2.31	1.16	16.10
5	14.34	1.06	1.06	15.65
6	14.30	0.04	0.04	15.42
8	13.84	0.86	0.43	14.90
10	13.31	0.53	0.27	14.24
12	12.59	0.72	0.36	13.95
16	12.51	0.08	0.02	13.69
20	12.50	0.01	0.003	13.76
24	11.53	0.97	0.24	12.25
30	11.04	0.49	0.15	12.38

The average C. V. per cent (unadjusted) varied from 20.69 for one unit plot size to 11.04 for thirty unit plot size (Table 1), while C. V. per cent (adjusted) varied from 20.69 to 12.38 for the same range of plot size (Table 1). The C. V. per cent gradually decreased with the increase in plot size. Decrease in C. V. per cent with increase in plot size in case of paddy crop was also reported by Abraham and Vachhani (1964) and Agrawal and Deshpande (1967).

A further look into C. V. per cent (unadjusted) revealed that the reduction was more in beginning and then decrease become marginal. The average C. V. per cent (unadujsted), beyond 12 units plot size was not proportional to the area added in forming large sized plot. The results are in agreement with the results reported by Abraham and Vachhani (1964) and Agrawal and Deshpande (1967).

The difference between C. V. per cent of the consecutive points (plot size) may help to estimate per unit decrease in C. V. per cent and thereby the point of maximum curvature. The per unit decrease in C. V. per cent (unadjusted) decreased with the increase in the plot size upto 10 units (Table 1). Beyond 10 units plot size, the decrease in C. V. per cent was not proportional to the amount of land used in forming large sized plots. The optimum plot size is just beyond the point of maximum curvature (Figure 1). Therefore, 12 units plot size was considered as an optimum plot size for paddy.

The correlation among adjacent units ('b' = 0.4052) when used in adjustment, increased the variance per unit (Vx). The relation derived by Smith (1938) to estimate Vx is $Vx = V_1 / X^b$ where 'b' varies from 0 to 1. The C. V per cent adjusted were high as compared to C. V. per cent unadjusted (Table 1). The optimum plot

TABLE 2

Comparable variance and relative information for different plot size of summer paddy.

Size of plot (X)	*Observed variance (Vx)*	*Comparable variance (V)*	*Relative information (%)*
1	3651	3651	100
2	5355	2677	68
4	7895	1974	64
5	8775	1755	42
6	13070	1728	28
8	13066	1633	28
10	15104	1510	24
12	16179	1348	23
20	26769	1338	14
24	27229	1135	13
30	34664	1155	11

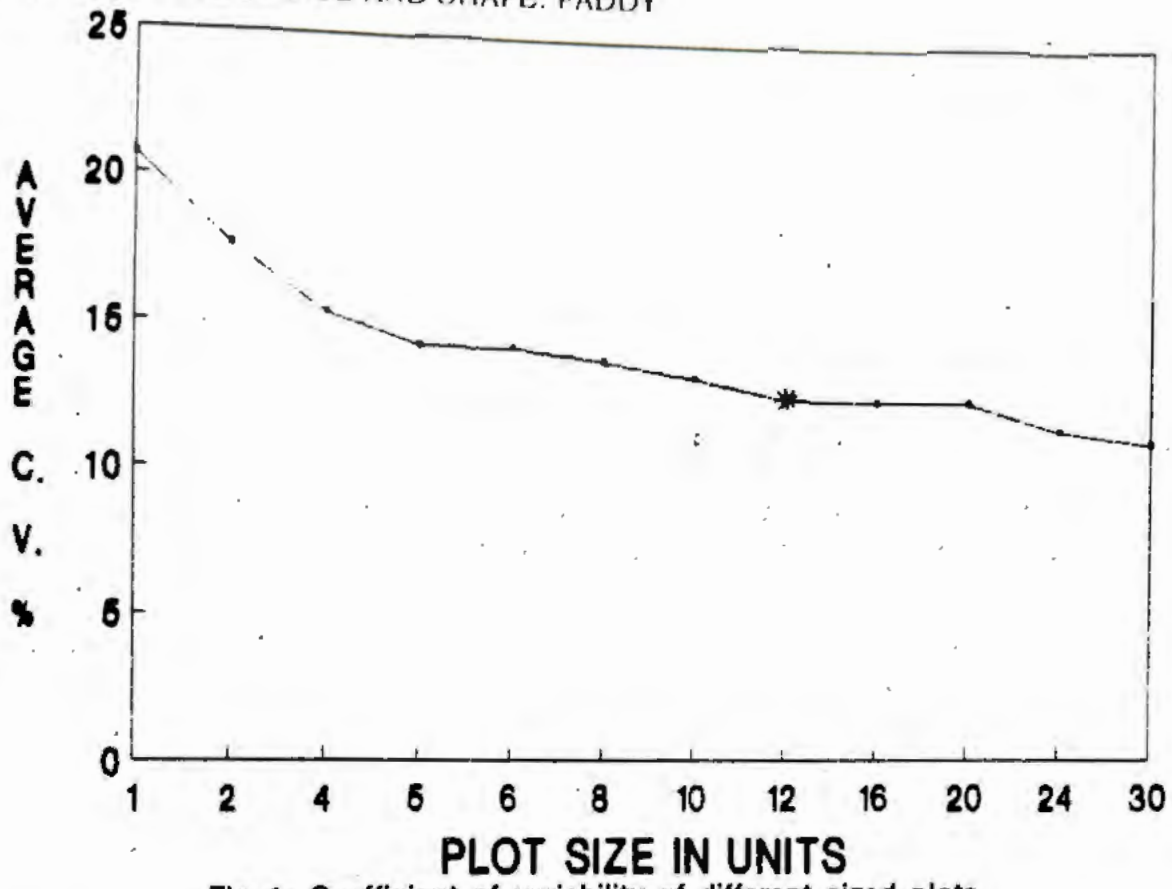

Fig. 1: Coefficient of variability of different sized plots

size worked out on the basis of Smith's formula depends on K2 (the cost proportional to total area per treatment) which varies with the nature of the experiment. It is rather difficult to arrive at exact value of K2 for each and every experiments. Therefore, K2 imposes limitations in defining the exact value of the optimum plot size. The Smith's variance law, thus provides only guideline in determining the optimum plot size. Pearce (1976) also showed that Smith's law lacks theoretical basis.

The comparable variance (V) and relative information (RI) were calculated for different sized plot (Table 2). If the occurrence of plots were completely at random (completely heterogeneity) then b=1 and from the equation by Smith (1938), we have $XVx = V_1 = V$.

Thus under the assumption of randomness, the comparable variance is constant and any plot size will give 100 per cent relative information. However, such a situation is hardly possible due to the correlation among adjacent plots. Hence increase in plot size should results in decrease in variance (Vx) and relative information.

The results (Table 2) revealed that the variance (Vx) and relative information decreased as the plot size increased. The variance (Vx) of basic unit was assumed to contribute 100 per cent relative information which is the greatest relative information (Keller, 1949). The decrease in Vx and relative information was rapid in the beginning upto 6 units size plot (3651 to 1728 and 100 to 28 per cent in Vx and relative information respectively) and thenafter decrease becomes gradual. In general Vx and relative information decreased as plot size increased (Keller, 1949). Since the decrease in Vx and relative information beyond 12 units plot size, was not proportional to the area added, a 12 unit plot size could be considered as an optimum plot size.

In order to estimate the optimum plot size due to plot shape, comparable variance (V) and relative information (RI) were calculated for two sets of plot size viz., X1 > X2 and X1 < X2 where X1 is length of plot along the row and X2 the width across the row (Table 3). An examination of data (Table 3) reveales that V increased and RI decreased as plot size increased. The same result was observed by Keller (1949) who developed this method. In general, the variance per unit area in both the cases remained more or less stabilized after 12 basic units and hence optimum plot size can be safely fixed at 12 times basic units. Another interesting information is that the variance is minimum when length of row is increased

TABLE 3

Average variance per basic unit, comparable variance and relative information for different shapes of plot (X1 > X2 and X1 < X2) of summer paddy.

Size of plot (X) (X1 > X2)	*Observed variance (Vx)*	*Comparable variance (V)*	*Relative information (RI %)*	*Regression coefficient (b)*
2 (2 x 1)	5413	2707	67	0.4316
4 (4 x 1)	7741	1935	47	0.4579
5 (5 x 1)	8775	1755	42	0.4551
6 (6 x 1)	9760	1627	37	0.4510
8 (8 x 1)	12743	1593	29	0.3988
10 (5 x 2)	15104	1510	24	0.3834
12 (6 x 2)	15974	1331	23	0.4060
12 (4 x 3)	16203	1350	23	0.4004
20 (5 x 4)	26769	1338	14	0.3350
(X1 < X2)				
1 (1 x 1)	3651	3651	100	–
2 (1 x 2)	5296	2648	69	0.4635
4 (1 x 4)	8049	2012	45	0.4298
6 (1 x 6)	10400	1733	35	0.4158
6 (2 x 3)	10951	1825	33	0.3869
8 (1 x 8)	12937	1617	28	0.3917
8 (2 x 4)	13517	1690	27	0.3704
12 (3 x 4)	17000	1417	21	0.3808
12 (2 x 6)	17572	1464	21	0.3678
24 (4 x 6)	27229	1135	13	0.3676

rather than taking more number of rows i.e. rectangular plot.

Among all combinations of 12 units plot, a plot of 10 rows each of 6.3 m length (6 x 2) had minimum observed variance (Table 3) and there by minimum unadjusted C. V. per cent. The results therefore, leads to the conclusion that 12 units plot (2 m x 6.3 m) is an optimum plot size for summer paddy (Cv. IR 8) in Navsari zone of Gujarat State.

REFERENCES

Abraham, T. P. and Vachhani, M. V. (1964). Size and shape of plots and blocks in field experiments with transplanted rice crop. *Indian J. Agric. Sci.* **43** (2) : 152-65.

Agrawal, K. N. and Daeshpande, M. R. (1967). Size and shape of plots and blocks in field experiments with dibbled paddy. *Indian J. Agric. Sci.* **37** (6) : 445-55.

Federer, W. T. (1955). Experimental design - theory and application. MacMillan & Co., New York, 2nd Ed., pp. 58.

Hatheway, W. H. and Williams, E. J. (1958). Efficient estimation of relationship between plot size and the variability of crop yields. *Biometrics.*, **14** : 207-22.

Keller, K. K. (1949). Uniformity trials on shops (*Humulus lupulus* L.) for increasing the precision of field experiments. *Agron. J.*, **41** (8) : 389-92.

Koch, E. J. and Rigney, J. A. (1951). A method of estimating optimum plot size from experimental data. *Agron. J.*, **43** : 17-21.

Patel, N. M. and Patel, R. M. (1968). Plot technique in Bajri. (*Pennisetum typhoides* S & H) *B. A. Col. Mag. GAU*, pp. 89-97.

Pearce, S. C. (1976). An examination of Fair-field Smith's variance law of experimental variation. *J. Agric. Sci.*, **87** : 21-24.

Smith, H. F. (1938). An emperical law describing the heterogeneity in the yield of agricultural crops. *J. Agric. Sci.*, **38** : 1-23.