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Optimum Size and Shape of Plot for Field Experiments on Gram

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ABSTRACT

A uniformity trial was conducted during *rabi* season of the year 1993 at the Agricultural Research Station, Gujarat Agricultural University, Derol, Gujarat State to determine the optimum plot size and shape for field experiments on gram crop. The coefficient of variation (CV) decreased with an increase in plot size upto 4 m^2 for grain weight as well as for biomass weight. The rate of decrease in CV was rapid in the East-West direction for both characters. The plot shape had a little influence on variability. Smith's (1938) equation $Y = aX^{-b}$ explained the relationship between coefficient of variation (Y) and plot size (X). The variation explained for grain weight and biomass weight were found to be 86.67 and 89.24 per cent, respectively. Plot size of 4 x1 m^2 with 3 replications was considered as an optimum size and shape of plot for field experiments on gram.

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INTRODUCTION

Efficient planning of any field experiment depends on the magnitude of experimental error (which is usually expressed in terms of coefficient of variation in per cent) associated with various (assignable/non assignable) factors. Variation in soil fertility is a major source of experimental error (Federer, 1955). The knowledge of variation in soil fertility of the Agricultural Research Station, Derol is evaluated through a uniformity trial on gram to determine the optimum size and shape of plot for field experimentation on gram for which the information is lacking for Middle Gujarat.

MATERIALS AND METHODS

A uniformity trial on gram crop was conducted during the *rabi* season of the year 1993 at the Agricultural Research Station, Gujarat Agricultural University, Derol with recommended agronomical practices. The crop was sown in rows along North-South direction with a spacing of 30 cm between rows. A plot of 24 m wide and 30 m long in a contiguous unit of 1 m^2 giving in all 720 units was harvested to collect the data on grain weight and biomass weight for each unit, separately. The yield of adjacent units were combined to form the all possible combinations of different sizes and shapes of plots.

The coefficient of variation in per cent (CV) for all possible combinations of various plot sizes and shapes were calculated for both characters separately using the relationship given by the equation 1 (Gomez and Gomez, 1984).

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$$CV = \frac{\left[(1/N)\ \sum_{i=1}^{N} (zi - \bar{z})^2\right]^{1/2}}{\bar{z}} \quad \ldots\ldots (1)$$

where, zi (i = 1, 2, ..., n) is the i th value of the characteristic under study,

$\bar{z}$ = Mean value = $\frac{1}{N} \sum_{i=1}^{N} zi$ and

N = Number of observations of the characteristic

The method of "Point of Maximum Curvature" was employed to obtain the optimum plot size (Day, 1920). The optimum plot size was considered the point on the curve where the rate of change in CV was found to be maximum.

The relationship between CV (Y) and plot size (X) was examined through the Smith's (1938) equation as

$$Y = a X^{-b} \quad \ldots\ldots (2)$$

The number of replications for different plot sizes were worked out by the formula

$$r = (CV)^2 / p^2 \quad \ldots\ldots (3)$$

where, CV was the average coefficient of variation over different plot shapes for a fixed plot size and p was the standard error of means (S. Em.) at 90 per cent of confidence interval (Rambabu *et al.*, 1980).

The total area required for an experiment was obtained by multiplying the plot size with the number of replications at p per cent S. Em. for different sizes of plots. Land use efficiency

TABLE 1

Coefficient of variation for thirty eight different dimensions.

Plot size	*Shape of plot*		*Coefficient of variation (%)*				*Predicted CV on Smith's equation*	
(m^2)	*Width in meter*	*Length in meter*	*Grain weight*	*Average for plot size*	*Biomass weight*	*Average for plot size*	*GW*	*BW*
1	1	1	30.10	30.10	26.98	26.98	28.79	26.48
2	2	1	21.21	23.30	18.65	20.91	23.25	21.24
	1	2	25.38		23.17			
3	3	1	18.08	20.45	16.25	18.77	20.51	18.67
	1	3	22.82		21.29			
4	4	1	15.86	16.72	14.71	15.18	18.77	17.03
	2	2	17.57		15.64			
5	5	1	20.47	20.47	18.83	18.83	17.52	15.87

1.	2.	3.	4.	5.	6.	7.	8.	9.
6	6	1	13.93	16.30	12.01	14.77	16.57	14.97
	3	2	15.37		13.72			
	2	3	15.95		14.79			
	1	6	19.96		18.57			
8	8	1	12.43	12.82	11.09	11.88	15.16	13.66
	4	2	13.22		12.68			
9	3	3	14.42	14.42	13.31	13.31	14.62	13.16
10	2	5	14.06	16.13	12.68	14.58	14.16	12.73
	1	10	18.19		16.48			
12	12	1	10.21	12.16	8.37	10.90	13.38	12.01
	6	2	12.22		10.34			
	4	3	12.52		12.38			
	2	6	13.70		12.54			
15	3	5	12.70	15.04	10.91	13.35	12.49	11.18
	1	15	17.37		15.78			
16	8	2	10.44	10.44	9.51	9.51	12.24	10.96
18	6	3	11.84	12.12	10.40	10.64	11.80	10.55
	3	6	12.40		10.88			
20	4	5	11.34	11.56	10.85	10.49	11.43	10.21
	2	10	11.78		10.14			
24	24	1	6.66	9.07	5.97	8.33	10.80	9.63
	12	2	8.33		6.98			
	8	3	10.29		9.56			
	4	6	11.00		10.81			
30	6	5	10.76	12.40	9.11	10.48	10.08	8.97
	3	10	11.38		9.26			
	2	15	11.17		9.26			
	1	30	16.27		14.31			
36	12	3	8.21	9.36	7.09	8.11	9.53	8.46
	6	6	10.52		9.13			

for various plot sizes were computed with respect to 1 unit plot area (Patel and Patel, 1968).

RESULTS AND DISCUSSION

The comparisons were made among 17 different plot sizes on the basis of CV criterion which covered 38 different plot shapes. The CV obtained for different sizes and shapes of plots for both characters (i.e., grain weight and biomass weight) were presented in Table 1.

Optimum plot size : It can be observed from Table 1 that CV decreased with an increase in plot size in either directions. This result was parallel to those reported by Agarwal and Deshpande (1967) and Patel and Patel (1968). The decreased was more rapid with an increased in plot size along with than length for grain weight as well as biomass weight. CV decreased from 30.10 to 16.72 per cent for grain weight and from 26.98 to 15.18 per cent for biomass weight, respectively when the area per plot increased from 1 unit to 4 units. Thereafter, a consistent decreased was not observed, hence, 4 units plot size (i.e., 4 m^2) was considered an optimum plot size for field experimentation on gram crop. The same result can be also be observed from Figure 1.

Optimum plot shape: For a fixed plot size, the plot shape indicates a consistent effect on CV. It was found less for plots having greater width than length, however, compact plots showed more variability than plots elongated in E-W direction for both characters. Among all combinations of 4 m^2 plot, a plot shape of 4 width 1 m length had a minimum CV (15.86 per cent) for grain yield. In case of biomass weight, a plot shape of 4 m width and 1 m length showed a minimum CV (14.71 per cent). It can be revealed from Table 1 that a plot of 4

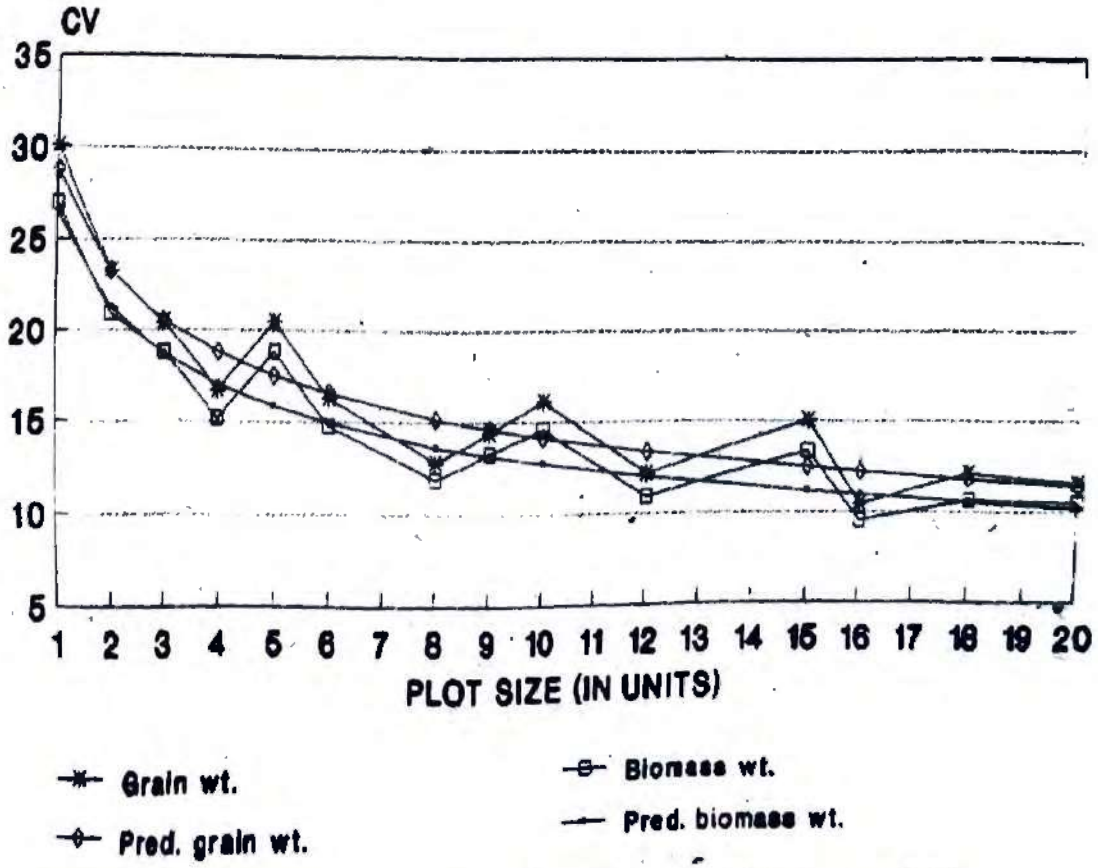


Fig. 1. : Observed and predicted CV for grain and biomass weight.

units having the shape of 4 m along width and 1 m along length could be considered an optimum plot shape for field experiments on gram crop.

Soil heterogeneity index : Smith's coefficient of soil heterogeneity index, 'b', for grain weight and biomass weight were found to be 0.3083 and 0.3182 which indicate change in number of replications and plot siz would be effective in reducing the experiment variability (Lin and Binns, 1986) with 86.67 an 89.24 per cent of variation as explained by th relationship between CV (Y) and plot size (X respectively. The estimated form of Smith equations are presented in Table 2.

TABLE 2

Smith's equation (estimated) for grain and biomass weight.

Character	*Smith's equation*	*Variation explained (in per cent)*
Grain weight	Y = 28.78 X (-0.3083)	86.67
Biomass weight	Y = 26.48 X (-0.3182)	89.24

Number of replications and relative land use efficiency :

The number of replications and required area of land for different plot sizes at 10 per cent standard error of means were computed from estimated CV for grain weight and biomass weight (Table 3). Table 3 showed that the number of replications and the relative land use efficiency of a plot decreased as the size of plot increased. These results were in agreement with the results obtained by Rambabu *et al.* (1980) and Sethi (1985). Due to practical difficulties in conducting the field experiments with small plots, a plot size, having relatively high efficiency with less number of replications should be considered for field experimentation (Ali and Singh, 1986). Such a situation arises for the plot of size 4 m^2, which is having considerably less number of replications (3) and a high land use efficiency (83.33 per cent) for grain weight. Therefore, 3 replications could be consider optimum number of replications for 4 un plot size at 10 per cent probability level grain yield. Parallel result was observed biomass weight with a minimum number 3 replications and 66.67 per cent of land u efficiency.

Conclusion

Coefficient of variation per unit a decreased with an increased in plot size up 4 m^2, thereafter a consistant decrease v not found. The plot shape had a little influe on variability within the range of plot s considered. For a given area, the small plot was found to be the most efficient. T number of replications required for a gi level of accuracy decreased with an increase plot size. Considering the characters, viz., gr weight and biomass weight simultaneously, was concluded that 4 m^2 plot size wit

TABLE 3

Number of replicaions and area required for 10% SE of mean and relative land use efficiency in per cent for grain weight (GW) and biomass weight (BW) with respect to unit plot size.

Plot size (m^2)	*CV*		*No. of replications*		*Area required (in units)*		*Relative land use efficiency*	
	GW	*BW*	*GW*	*BW*	*GW*	*BW*	*GW*	*BW*
1	30.10	26.98	10	8	10	8	100.00	100.00
2	23.30	20.91	6	5	12	10	83.33	80.00
3.	20.45	18.77	5	4	15	12	66.67	66.67
4	16.72	15.18	3	3	12	12	83.33	66.67
5	20.47	18.83	5	4	25	20	40.00	40.00
6	16.30	14.77	3	3	18	18	55.56	44.44
8	12.82	11.88	2	2	16	16	62.50	50.00
9	14.42	13.31	3	2	27	18	37.04	44.44
10	16.13	14.58	3	3	30	30	33.33	26.67

replications could be considered an optimum plot size. 12 rows each of 1 m length was found to be the optimum plot shape for the optimum plot size (4 m^2). Therefore, 4.0 x 1.0 sq. m was considered the best size and shape of plot for field experimentation on gram crop.

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