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Variability in Grain Number and Grain Weight and Sample Size for their Estimation in Bengal Gram.

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ABSTRACT

Bengal gram was grown under three different plant spacings (30 × 10 cm, 45 × 10 cm and 30×20 cm) during 1973 *Kharif* season at Tamil Nadu Agricultural University experimental farm. At the time of harvest, 50 plants in the centre of each plot were selected at random and data on grain weight per plant and grain number per plant were collected. Considering replication as primary sampling units and plants within plots secondary sampling units, variance components *viz.*, variance among plants within plots were estimated for the two characters seperately at each spacing using analysis to variance technique. It was observed that more than 86 per cent variability was attributed among plants within plots and rest among plots. Plants spaced with 45 × 10 cm and 30 × 20 cm exhibited more variation than plants with 30 × 10 cm suggesting selection of more sample plants in wider spaced treatments for estimation purpose. The relationship between mean and variance indicated that the two characters can be analysed with original values and their means compared in comparative experiments. To estimate grain weight per plant and grain number per plant with a precision of 5 per cent standard error, a minimum of 116 and 65 plants respectively were considered necessary.

INTRODUCTION

Information on grain weight per plant and grain number per plant is necessary in order to evaluate the imposed treatments in agronomic and breeding experiments in Bengal gram. It is not always possible and desirable to harvest the entire plot and determine the parameter values and hence they have to be estimated by representative samples with desired precision. The number of samples taken should give as close an estimate of the measure which would have been obtained had the measurements been made of the whole plot. The sampling variability of the character must be known in order to fix the sample size for the different characters. Variability of the above two characters was studied under three different plant spacings in Bengal gram (*Cicer arietinum*) and the sample sizes needed for varying degrees of precision in their estimation were determined and the results obtained have been reported in the paper.

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MATERIALS AND METHODS

An experiment was laid out with CO 1 variety Bengal gram in randomized block design with three replications and three different spacings namely 30 x 10cm, 45 x 10cm and 30 x 20cm with plot size measuring 4.50 x 3.00m. Two seeds per hill were sown initially and on 20th day after sowing, thinning operation was done to retain one healthy plant in each hill. Each plot received nitrogen and phosphate basally at 10 kg/ha each in the form of urea and super phosphate respectively. The crop was sown 17-11-1973 in the Tamil Nadu Agricultural University experimental farm. At harvest (20-2-1974) fifty plants in the centre of each plot were fixed at random and data on grain number per plant and grain weight per plant were collected.

The total population was subdivided into primary sampling units (plots) and they were in turn divided into secondary sampling units (plants) on which the measurements were made. The nested sample was obtained by considering as a random selection of three plots as primary units and 50 plants in each of the primary unit as secondary sampling units. The structure of the mathematical model, as outlined by Snedecor *et al.* (1967), followed in the analysis of variance is given below:

$$X_{ij} = \mu + T_i + E_{ij} \quad \ldots\ldots\ldots(1)$$

$i = 1,2$ and 3 where i refers to the number of plots

$j = 1,2 \ldots 50$ where j refers to the number of plants

The value μ represents the general mean and is thus a fixed constant. The components T_i and E_{ij} are random variables with mean and covariances equal to zero and with variances equal to σ^2_p and σ^2_s respectively called variance components. Analysis of variance model as shown in table 1 was used seperately for each character and treatment. Variance components σ^2_p and σ^2_s were estimated by equating the expected mean squares to the observed mean squares as follows:

$$MS\ 2 = \sigma^2_s + 50\,\sigma^2_p \quad \ldots\ldots \quad (2)$$

$$MS\ 1 = \sigma^2_s \quad \ldots\ldots \quad (3)$$

Solving the equations 2 and 3, estimates of $\sigma^2_s = MS\ 1$ and $\sigma^2_p = \dfrac{MS2\text{-}MS1}{50}$ were obtained. As pointed out by Stickler *et al.* (1961) by expressing each

TABLE 1. Form of analysis of variance and expected mean squares for the estimation of variance components (Two-fold nested classification based on equal numbers)

SV	df	MS	E (MS)
Among plots	2	MS 2	$\sigma^2_s + 50\,\sigma^2_p$
Among plants within plots	147	MS 1	σ^2_s
Total	149		

component of variance as a per cent of total variation, the experimenter is able to evaluate the relative importance of each source of variation. The linear relationship between mean and variance ($s^2 = a + b\bar{x}$) was studied seperately for each character to know whether transformation of the original data by either square root or logarithmic transformation to validate the use of analysis of variance technique in comparative experiments is required. Coefficient of variation for the different characters were computed to know the amount of variability among these chearacters in the different treatments. Choice of sample size was derived for different levels of precision using the sample relationship $n = \left(\frac{CV(x)\%}{CV(\bar{x})\%}\right)^2$ where

$CV(x)\% = \frac{s}{\bar{x}} \times 100\%$ (coefficient of variability of a single observation)

$CV(\bar{x})\%$ = desired precision of the estimator, $\bar{x}$

s = sample standard deviation.

$\bar{x}$ = sample mean.

RESULTS AND DISCUSSION

Estimates of variance components shown in table2 indicated that more than 86 per cent variability in grain weight per plant and grain number per plant was attributable to variation among plants within plots and the rest 14 per cent to variation among plots. This fact has further been confirmed by the high CV (per cent) observed among the plants within plots. A relatively larger variation among plants with wider spacings was observed. This could be possible due to

TABLE 2. Estimates of variance components among plots, among plants within plots, plot component error, sampling error and mean of the two characters under different spacings

Character	particulars	Treatment 30 × 10 cm	45 × 10 cm	30 × 20 cm
Grain weight per plant	Mean (gm)	8.1	10.9	13.5
	Variance among plants within plots	14.8 (85.5)	35.0 (96.5)	40.0 (100)
	Variance among plants	2.5 (14.5)	1.3 (3.5)	0 (0)
	Plot component error as % of the mean	2.92	1.81	0.86
	Sampling error as % of the mean	47.44	53.87	46.70
	Standard error	2.2	3.4	3.7
Grain number per plant	Mean	57.8	78.7	90.66
	Variance among plants within plots	739.7 (86.3)	1620.6 (95.9)	1471.6 (90.3)
	Variance among plants	117.7 (13.7)	69.5 (4.1)	157.5 (9.7)
	Plots component error as % of the mean	2.82	1.81	2.13
	Sampling error as % of the mean	47.50	51.18	42.31
	Standard error	15.7	23.2	22.2

Figures in parenthesis indicate per cent variability wider spread of the plants producing more number of grains and consequently more grain weight. The per cent sampling error varied from 42.3 to 51.2 in case of grain number per plant and from 46.7 to 53.9 in case of grain weight per plant. This fact suggested that equal number of plants for the estimation of these two characters will not be appropriate. Regression analysis between variance and mean indicated on relationship between these two statistics and hence the original values could be used without any transformation in the analysis of variance and the means compared.

The size of sample (n) needed for a desired per cent standard error for the two characters under different plant spacings is given in table 3. It is seen that underspacing (45 x 10 cm

TABLE 3. Size of sample (n) needed for a desired percentage of standard error (CV ($\overline{X}$) = 1,2, 10) for the two characters under three different spacings

Character	% SE	Treatments		
		30 × 10 cm	45 × 10 cm	30 × 20 cm
Grain weight / plant	1	2251	2902	2181
	2	563	725	545
	3	250	322	242
	4	141	181	136
	5	90	116	87
	6	63	81	61
	7	46	59	45
	8	35	45	34
	9	28	36	27
	10	23	29	22
Grain number / plant	1	740	1621	1471
	2	184	405	367
	3	82	180	163
	4	466	101	92
	5	30	65	59
	6	21	45	41
	7	15	33	30
	8	12	25	23
	9	9	20	18
	10	7	16	15

and 30 x 20 cm) about two times as much samples as that of 30 x 10 cm was required for a given degree of precision. A minimum of about 116 and 65 plants have to be considered for the estimation of grain weight per plant and grain number per plant respectively in order to estimate them with a precision of 5 per cent standard error in experiments having different plant spacings.

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