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ESTIMATION OF OPTIMUM PLOT SIZE, NUMBER OF REPLICATIONS AND NUMBER OF SAMPLING UNITS FOR FABA BEAN YIELD TRIALS

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ABSTRACT

This investigation was undertaken to study the optimum plot size, number of replications and number of sampling units for faba bean yield trials at Sids Agric. Research Station during 2002/2003 and 2003/2004 seasons. The experiment included 7 genotypes of faba bean cultivars. A randomized complete block design with three replications was selected. The area of each plot was 7.2 m^2. Data were subjected by two procedures, the first method was developed by Smith (1938) and the second method was the maximum curvature developed by Lessman and Atkins (1963).

The results obtained could be summarized as follows:

- Increasing plot size decreased the variance per basic unit and the coefficient of variability. However, the reduction was not in proportion with the increase in plot size.
- The index of soil variability ranged from –0.512 to –0.807 with an average of -0.660
- The exponential relationships between the coefficient of variability (C.V.) and plot size (X) were:

C.V.= 18.293 X-0.624 for the first season .
C.V.= 16.318 X-0.860 for the second season .

- The optimum plot size was resulted by two methods as follows:

I- Smith's method: The optimum plot size was 2.441 and 3.218 m^2 in the first and second seasons, respectively.

II- Maximum curvature method: The optimum plot size was 13.342 and 17.648 m^2 in the first and second seasons, respectively.

- Increasing plot size and/or number of replications reduced the magnitude of difference detected at specified level of significance. The reduction of difference with increasing plot size was less than that obtained by equivalent increase in the number of replications.
- The standard error for the studied characters decreased as number of sample units or replicates increased.
- Number of plants required to detect 10% change between means were markedly decreased as number of replicates increased.
- The optimum number of sample units differed from character to another and it was greatly affected by number of replications.

INTRODUCTION

Soil variability has been recognized as a major factor affecting the sensitivity of experimental results. Proper interpretation of field experiment results depends on the control of such variability. A great deal of the soil effect can be minimized by the choice of a proper design and the use of optimum plot size, number of replications, as well as number of sampling units in these fileds. The current investigation was carried out to estimate the index of soil variability, optimum plot size, number of replications and number of sampling units in experimental fields of faba bean. The effect of changing plot size and number of replications on the magnitude of the differences detected between means was also studied.

To investigate these problems, data from replicated field experiments can be used to measure the Smith's index of soil heterogenety and convenient number of sample units.

Smith (1938) reported a linear relationship between the logarithm for each variance among plots and plot size. He used this relationship together with out cost function to estimate plot size. Khalil *et al* (1970) found that, using smaller plots and more replications reduced both the standard error and the coefficient of variability. Galal and Abu El-Fittouh (1971) pointed out that the sensitivity of the experiment to detect differences of specified magnitude between treatment means is affected to some extent by either increasing number of replications or plot size.

Results on wheat of Kassem *et al.* (1971), demonestrated that the optimum plot size ranged from 1.2 - 2.4 m^2 at Alexandria. They stated that long narrow plots reduced significantly the variability among plots than short wide squared plots. They also reported that, as the plot size increased, the variance among plots and comparable variance were increased, but the variance per basic unit and the coefficient of variability decreased. At Gemmeiza and Sids, Hanna (1972) indicated that increasing number of replications were more effictive than increasing plot size. Hack (1976) reported that, the increasing in precision is obtainable by varying the number of plants sampled per plot, and the number of replicated plots per treatment, are considered in relation to their costs.

Cochran (1977) gave a solution to the optimum allocation problem, where an estimated optimum sample size minimizes the expected product of cost and variance. The minimum sample size required to detect specified true differences among treatment means may also be estimated for specified power and estimated variance (Steel and Torrie, 1980). El-Kalla and Gomaa (1977) reported an optimum plot size for wheat 3.0 m^2, using Smith's procedure for the two utilized locations. However, it was 7.0 and 5.0 m^2 by using modified maximum curvature technique for the previous two locations respectively. Plot shape had an effect on plot-to-plot variability. El-Bakry (1980), recorded that wheat needs plots of medium size. He found that the optimum size of plot at Sids ranged from 4.5 to 24.8 m^2. He also added that a long and narrow shape was generally more efficient as compared with square or nearly square shape. Abdel-Halim and Hanna (1980) using Koch and Rigney (1951) technique found that soil heterogeneity index of experimental fields for wheat ranged from 0.42 to 0.68, with an average of 0.58. The optimum plot size was found to range from 6.8 to 17.5 m^2 with an average of 12 m^2 computed from all trials. El-Rassas (1982) at Giza, found that the optimum plot size ranged from 3.2 to 6.4 m2. He stated that long and narrow plots were more effective in reducing variance per basic unit area, The same results were reached for comparable variance and coefficient of variability. Ismail *et al* (1982) discussed the sensitivity of statistical tests to detect differences of spicified magnitudes between treatment means. They climed an appreciable improvement by increasing the plot size and the number of replications Increasing the number of replications were more effective, even if small plots were used. They reported that, for data from plot sampling, an additional source of variation can be measured due to sampling variation, which is commonly referred to as sampling error.

To develop a plot sampling technique for the measurement of a character in a given trial, the researcher must clearly specify the sampling unit, the sample size, and the sampling design (Gomez and Gomez 1984). They also stated that the required sample size is governed by size of variability among sampling units within same plot and by the degree of precision desired to be detcted. Casler and Ehike (1985) pointed out that, increasing sample size or the amount of replications not only improves precision, but also increases the cost. A scientist must make the decision of how best to allocate resources so that (i) the experiment can be completed within a required time from or within a maximum amount of funds and (ii) trearment means and variances are estimated with the precision (low variance) required. Lefoet (1987) indicated that, the optimum number of experimental units were strongly depends on the land characteristics as well as on the nature of measured variable, and on expected error variance and differences between means considered economically significant. Surin (1992) found that, when using sample size between 20-24% of the total number of plants, systematic sampling has higher efficiency in estimation than simple random sampling. Zedaker, *et al.*(1993) reported that, the ability to detect small differences is dependent upon the relationship among sample size, type I and II error probability, and the coefficient of variation of the data. Nasr and leilah (1993) and Salem and Salama (2001) pointed out that, the standard error decreased as number of sample units or replications increased. Number of plants required to detec 10% change markedly decreased as number of replications increased.

So, the objective of this study was to determine the balance between optimum plot size, sample units and number of replications to detect real differences between treatment means in faba bean yield and its components.

MATERIALS AND METHODS

1- Lay out of the experiment:

Two faba bean field experiments were carried out at Sids Agric. Research station during two successive seasons (2002/2003 and 2003/2004). The experiment included 7 genotypes of faba bean namely; (Giza 2, Giza 429, Giza 674,Giza 40, Comp. 72/1897/88, 812/742/92 and 822/1073/92). The experimental design was a randomized complete block with three replications. Experiments were sowen on 15 November in each season. Sampling data were taken randomly from ten plants from each plot consisted of 4 ridges, each of 3 m long and 60 cm apart. The area of plot was 7.2 m^2 (1.8 x 4 = 7.2 m^2) plant spacing was 15 cm. Data were recorded for the following characters:

1-Number of branches/plant 2-Number of pods/plant

3-Weight of pods gm

4-Weight of 100 seed

5-Seed yield/plant (gm)

2- Statistical analysis procedures:

2.1 Optimum plot size:

A- Soil heterogeneity index:

The procedure (reported by Gomez and Gomez ,1984) involves the use of the basic analysis of variance to estimate the variance for plots of different sizes, and the use of these estimates to derive a relationship between plot variance and plot size. The number of plot variances that can be estimated through this procedure is only as many as the number of plot sizes available in the design used.

The steps of procedure are:

1-The basic formats of the analysis of variance for a Randomized Complete Block design with sampling error are shown in Table 1.

Table (1):Basic format of the analysis of variance for randomized complete block design with sampling error, formulas for the computation of variances between plot of various sizes.

Source of Variation	Degree of Freedom	Mean Square	Variance between plots Various size
Replication	r-1	M1	$V_1=M_1$
Treatment	t-1		
Experimental Error	(r-1) (t-1)	M2	$V_2=\frac{r(t-1)M2+(r-1)M1}{rt-1}$
Sampling Error	Tr (s-1)	M3	$V_3=\frac{tr(s-1)M3+(r-1)M1+r(t-1)M2}{rts-1}$
Total	Rts-1		

2- Compute estimates of the variance associated with the different plot sizes, following the formulas given in Table 1. In this study, the design is a randomized complete block design with sampling error. Hence, there are three variances between-plot corresponding to the three plot sizes as follows:

V'_1 = the variance between plots of blocks

V'_2 = the variance between plots of genotypes

V'_3 = the variance between plots of a sampling

The computation of these variances is based on the mean square values in the analysis of variance (Table 1) .

3- For each variance estimate V_i obtained in step 2, compute the corresponding comparable variance V_i with the size of the smallest plot in the particular experiment as the base:

$$V_i = \frac{v'i}{x}$$

where: x is the size of the *ith* plot in terms of the smallest plot involved.

4- Apply the appropriate regression technique to estimate regression coefficient b (the index of soil heterogenety) from the equation:

$$\log V_i = \log V_3 - b \log X_i$$

Where *Vi* and *Xi* are defined in step 3.

B- Optimum plot size (*X* opt.)

The weighted index of soil variability, *b*, as published by Federer (1955), was calculated ignoring cost factors, the optimum plot size (*x* opt.) was determined, using the method developed by Smith (1938), by the equation:

1-*X* opt. = *b* / (*1- b*)

The exponential relationship between the coefficient of variability (*C.V.*) and plot size (*X*),

$C.V. = A X^{-B}$, was transformed into the logarithmic form:

2-*log C.V. = Log A - B log X*

where *A* and *B* are the Y-intercept (constant of the equation) and regression coefficient, respectively.

The values of *A* and B in the above equation were estimated from the values of *C.V.* of replications, experimental error and sampling error to determine the point of maximum curvature (*C max.*). The values of A and B were substituted in the following formula which was developed by Galal and Abou-El-Fittouh (1971).

$$C\ max = [A^2 B^2 (2B+1)/(B+2)]^{1/(2B+2)}$$

The point of maximum curvature indicates a critical value of the optimum plot size .

2.2 Convenient number of replications and sample size:

The statistical model for the design is:

$$Y_{ijk} = U + B_i + T_j + BT + E_{ij} + S_{ijk}$$

Where: I =1,2,....,(treatments), j = 1,2,...(blocks), k = 1,2,....(sampling units), B_I = blocks effect, E_{ij} = random experimental error, S_{ijk} = random sampling error.

The steps of procedure were as followes:

1-From estimating of experimental and sampling error.

$$S_1^2 = M3$$

$$S_2^2 = (M_2 - M3)/n$$

Where: M3 is the sampling error mean square, M_2 is the experimental error mean square in the analysis of variance and n is the sample size in field experiment. (see Table1)

2-Compute the estimates of the variance of strips mean and the corresponding coefficient of variability (cv) value as:

$$V(\bar{x}) = (s_2^2 + ns_3^2) / r\,n$$

$$CV(\bar{x}) = (100 * SQR(V(\bar{x})) / \bar{x}$$

Where r is the number of replications, $\bar{x}$ is the grand mean of the character.

3-Repeating this process by increasing the number of replications (r) or the sample size (n) to reach the convenient degree of precision. Two, four, six replications were used as the economic number of replications with inserting different number of samples (N = 1,2,3,...20 plants).

4-The convenient number of sampling units for each number of replication were determined by the point of miximum curvature (C max) for exponential equation between the coefficient of variability (C.V.) and sample units.

$$C.V. = A^{*} X^{B}$$

Were A is Y intercept and B is the regression coefficient

RESULTS AND DISCUSSIONS

Fertility gradient in the field was calculated by the analysis of variance conducted on the original data. The results of basic format of the analysis of variance for a rondomized complete block design are shown in Table 2. To determine the difference among mean squares between replications and experimental errors, variance ratios "F" were calculated by dividing mean squares of replications and experimental error on sampling error. These values were compared with the tabulated "F" values at the corresponding degrees of freedom. The results given in Table 2 indicated that there are significant differences, for the two seasons, showing the effect of plot size. They affect the experimental design and both size of plot and number of replications. Therefore, the variance was increased, when the plot size increased. Similar results were obtained by Kassem *et al* (1971).

Table (2): The analysis of variance results for a rondomized complete block design and "F" values for 2002/2003 and 2003/2004 seasons

Source of Variation	Degree of Freedom	Mean Square 2002/2003	F-value	Mean Square 2003/2004	F-value
Replication	2	1.848	0.025	31.95	0.48
Genotypes	6	779.74	10.44**	565.31	8.50**
Experimental Error	12	74.67	0.500	66.51	0.74
Sampling Error	189	149.301		89.99	

1- Soil heterogeneity index:

The weighted index of soil variability "b" was found to be -0.512 and -0.807 for the two successive seasons 2002/2003 and 2003/2004. These results are contradicting with those obtained by many workers who found that soil heterogenety is entermediate in field. Similar results were also reported by Koch and Rigney (1951) and Abdel-Halim and Hanna, (1980). They added that coefficient of soil heterogeneity "b" varied between zero and one. A value close to zero indicates ver uniform field, while a value near one might indicate a field very heterogeneous in soil fertility.

2- Optimum plot size:

Results presented in Table 3 indicated that plot variance increased due to increment in plot size. While coefficient of variability (C.V.) reduced when number of plots increased. Many investigators confirmed these results, among them Lessman and Atkins (1963), Kassem *et al* (1971) and El-Kalla and Gomaa (1977). However, this reduction is not in proportion with the increase in the size of plots. The rate of reduction decreases as the plots become larger. This confirms the fact that the relationship between plot size and the coefficient of variability is exponential in nature.

Table (3): Coefficient of variability (C.V.) of different plot size of three combinations from faba bean in two seasons.

Source of variation	2002/2003		2003/2004	
	Observed C.V. %	Estimated C.V. %	Observed C.V. %	Estimated C.V. %
Sampling Error	41.43	52.78	33.14	29.87
Experimental Error	29.30	15.66	28.49	5.60
Replication	4.13	7.89	19.76	2.18

The coefficient of variability decreased rapidly at first in the two seasons and then decreased slowly as plot size increased (Figures 1 and 2). This relationship was similar to that previously reported by all investigators studying the same problem.

The equation describing this relationship has the general form :

$C.V. = A X^{-B}$. The values of A and B were estimated and found to be 18.293,-0.624 for the first season and 16.318,-0.860 for the second season. Therefore. The equations were defined as:

$$C.V. = 18.293 X^{-0.624}$$
$$C.V. = 16.318 X^{-0.860}$$

The optimum plot size was calculated by the two following methods :

1- Smith's method: (Smith 1938)

The results in Table 4 indicated that, the optimum plot size using Smith's method was 0.339 and 0.447 basic units in the first and second seasons respectively. Consequently, the optimum plot size was ($0.339 \times 7.2m^2 = 2.441\ m^2$) in the first season and ($0.447 \times 7.2m^2 = 3.218\ m^2$) in the second season.

2- Maximum curvature method:

According to the Modified Maximum Curvature procedure, the optimum plot size was 1.853 and 2.451 basic units in the first and second season, respectively Table 4. Consequently, the optimum plot size was ($1.853 \times 7.2m^2 = 13.342\ m^2$) in the first season and ($2.451 \times 7.2m^2 = 17.648\ m^2$) in the second season.

The index of soil variability, b, was -0.624 in 2002/2003 season and -0.860 in 2003/2004 season. Theoretically, this index varies between zero and one. A zero value inperfect the basic units. On the other hand, unit index mean completely independence. In the two trials, the "b" value indicates that an intermediate degree of correlation is present.

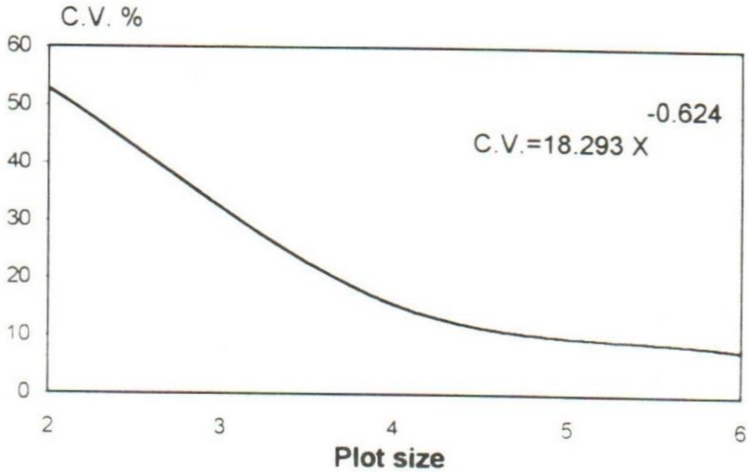


Fig. 1: Relationship between plot size and coefficient of variability (C.V.) for faba bean in season 2002/2003

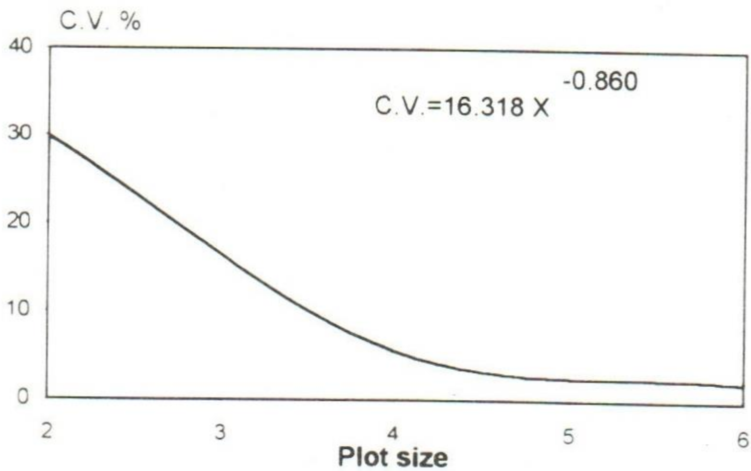


Fig. 2: Relationship between plot size and coefficient of variability (C.V.) for faba bean in season 2003/2004

Table (4): Optimum plot size for faba bean in two seasons as calculated by Smith's and maximum curvature methods.

Season	Smith's method			Maximum curvature method			
	Optimum plot size						
	b	In basic Unit	Area/m^2	A	B	In basic unit	Area/m^2
2002/003	-0.512	0.339	2.441	18.293	-0.624	1.853	13.342
2003/004	-0.807	0.447	3.218	16.318	-0.860	2.451	17.648
Mean	-0.660	0.393	3.830	17.306	-0.742	2.152	15.495

Using the obtained value of b in computing the optimum plot size for the two trials, it was found to be less than a basic unit . It should be noted that Smith (1938), pointed out that areas half or double the optimum plot size would be 96% as efficient as the optimum plot size, when b = 0.5 . The mean of optimum plot size over all two seasons was 3.83 m^2 by using Smith procedure. These results are in accordance with the findings of Abdel-Halim and Hanna (1980) and El-Rassas (1982).

Applying the maximum curvature method, the optimum plot size, was calculated as 1.853 and 2.451 basic units in the two seasons with a mean of 2.152 basic unit. Therefore, the recommednd size of plot is 15.495 m^2. El-Bakry (1980) confirmed these results.

The results of applying the two methods of determining the optimum plot size were different. The maximum curvature method resulted in larger plot sizes than the Smith's method for the two seasons. Therefore, it would be better to adopt the larger optimum plot sizes, because the results from experimental design are affected by systematic variation. This variation is directly related to the position of the plot in the field depending mainly on soil fertility gradients. In such cases, the systematic variability is removed by the larger plot size.

Convenient number of replication and sample units:

Sampling within experimental units is a common practice in field experiments. Important decisions to be made in planning experiments are the number of samples to take per experimental unit and the number of replications to be used.

Data in Tables 5, 6 and Fig. 3 (a, b, c, d and e) show the values of standard error for various combinations of number of replications (r) and number of sample (n) in randomized complete block design in (Number of Branches, Number of Pods, Weight of Pods, Weight of 100 seed and Seed yield/plant) were not the same, and the convenient number of sample units and replications depends upon the degree of variability of the character under study.

Data presented in Tables 5, 6 revealed that the required number of sample units to achieve the same level of precision with four and six replications were relativelaly low if compared with those required with two and four replications. This indicated that, increasing number of replications more than four had no high improvement in the degree of precision. But when the amount of lands is not available, it is better to increase the number of sample units.

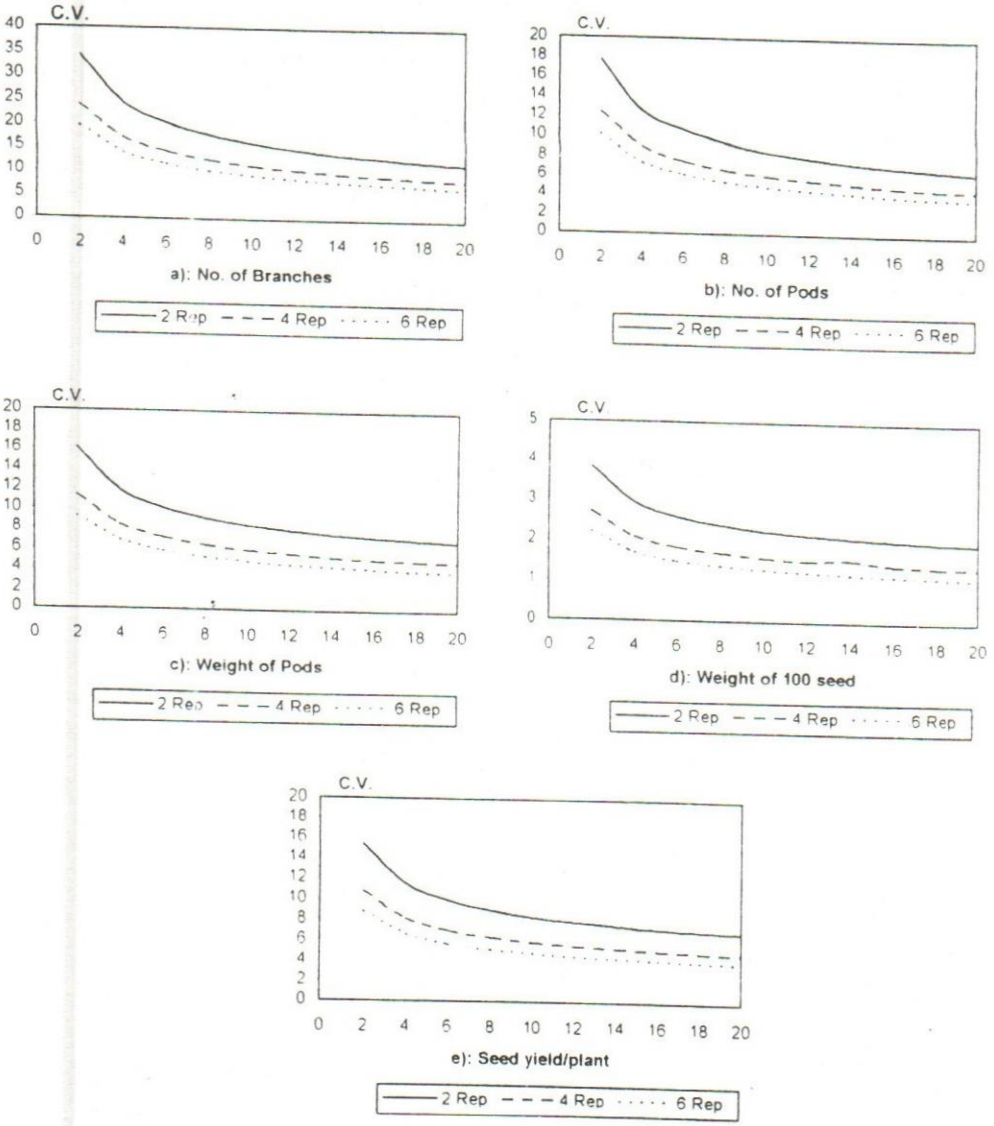
Table (5): Estimated standard error for different combinations of samples size and number of replications for yield and its components in faba bean in 2002/2003

Characters	No. of Rep.	Sample size									
		2	4	6	8	10	12	14	16	18	20
No. of Branches	(2)	44.87	31.87	26.13	22.73	20.42	18.72	17.40	16.35	15.48	14.74
	(4)	31.73	22.53	18.48	16.07	14.45	13.24	12.31	11.56	10.94	10.42
	(6)	25.91	18.40	15.09	13.12	11.79	10.81	10.05	9.44	8.93	8.51
No. of Pods	(2)	20.86	14.78	12.09	10.50	9.41	8.61	7.98	7.48	7.07	6.72
	(4)	14.75	10.45	8.55	7.42	6.65	6.09	5.65	5.29	5.00	4.75
	(6)	12.04	8.53	6.98	6.05	5.43	4.97	4.61	4.32	4.08	3.88
Weight of Pods	(2)	16.88	12.74	11.02	10.05	9.42	8.98	8.64	8.39	8.18	8.01
	(4)	11.94	9.01	7.79	7.11	6.66	6.35	6.11	5.93	5.78	5.67
	(6)	9.75	7.36	6.36	5.81	5.45	5.18	4.99	4.84	4.72	4.63
Weight of 100 seed	(2)	4.27	3.26	2.84	2.61	2.46	2.36	2.28	2.23	2.17	2.13
	(4)	3.02	2.30	2.01	1.85	1.74	1.67	1.61	1.57	1.53	1.51
	(6)	2.46	1.88	1.64	1.51	1.42	1.36	1.31	1.28	1.25	1.23
Seed yield/plant	(2)	15.30	11.77	10.33	9.52	9.01	8.65	8.38	8.17	8.01	7.88
	(4)	10.82	8.32	7.31	6.73	6.37	6.11	5.93	5.78	5.66	5.57
	(6)	8.83	6.79	5.96	5.50	5.20	4.99	4.84	4.72	4.62	4.55

Table (6): Estimated standard error for different combinations of samples size and number of replications for yield and its components in faba bean in 2003/2004

Characters	No. of Rep.	Sample size									
		2	4	6	8	10	12	14	16	18	20
No. of Branches	(2)	23.61	17.25	14.53	12.95	11.91	11.15	10.59	10.14	9.78	9.48
	(4)	16.69	12.20	10.27	9.16	8.42	7.89	7.48	7.17	6.91	6.70
	(6)	13.63	9.96	8.39	7.48	6.87	6.44	6.11	5.85	5.64	5.47
No. of Pods	(2)	14.70	10.39	9.35	8.44	7.85	7.43	7.11	6.87	6.67	6.50
	(4)	10.41	7.73	6.61	5..97	5.55	5.25	5.03	4.85	4.71	4.61
	(6)	8.49	6.31	5.40	4.87	4.53	4.29	4.12	3.96	3.85	3.76
Weight of Pods	(2)	15.55	11.20	9.31	8.21	7.46	6.92	6.51	6.19	5.92	5.70
	(4)	10.99	7.92	6.58	5.80	5.28	4.90	4.62	4.37	4.19	4.03
	(6)	8.98	6.47	5.38	4.74	4.31	3.99	3.76	3.57	3.42	3.29
Weight of 100 seed	(2)	3.47	2.68	2.35	2.17	2.05	1.97	1.91	1.86	1.83	1.80
	(4)	2.46	1.89	1.66	1.53	1.45	1.39	1.53	1.32	1.29	1.27
	(6)	2.01	1.54	1.36	1.25	1.19	1.14	1.10	1.08	1.06	1.04
Seed yield/plant	(2)	15.56	11.32	9.50	8.44	7.74	7.23	6.85	6.54	6.30	6.09
	(4)	11.00	8.01	6.72	5.97	5.47	5.11	4.84	4.63	4.45	4.31
	(6)	8.99	6.54	5.49	4.88	4.46	4.18	3.95	3.78	3.63	3.52

Fig. (3): Relationship between number of sample units and coefficient of variability (C.V.) for all characters that were studied in seasons 2002/2003 and 2003/2004



The present results are in harmony with these reported by Lefoet (1987). Results also indicated that, increasing number of Samples or replications decreased the values of standard error. However, increasing number of samples were proportional to the increase in number of replications. This conforms with the fact that the relationshop between number of samples and number of replications on the value of strandard error.

This relationship was similar to that previously reported by Casler and Ehike (1985), Nasr and Leilah (1993) and Salem and Salama (2001). Also, results revelts that, the required number of sample units to achieve the some level of precision with number of replications indicated that, oncreasing number of precision. But when the amount of hand is not available, it is better to increase the number of sample units. The present results are in good agreement with those reported by El-Kalla *et al*, 1981and Nasr and Leilah (1993).

Data in Table 7 shows in results of minimum sample size over all two seasons required to detect specified true differences among treatment means for the different studied characters. They can be those the convenient number of samples and number of replications according to the maximum curvature techique from exponential equation between standard error of the treatment mean (CV(X)) and number of sample units for each number of replications (2,4 and 6) The optimum number of sample units differed in a relatively wide rang (3 to 16 units) from character to another character.

Table (7): The mean convenient number of sample unites and number of replications in two seasons 2002/2003 and 2003/2004 season

Characters	2 Replications		4 Replications		6 Replications	
	C.V. (X)	No. of Samples	C.V. (X)	No. of Samples	C.V. (X)	No. of Samples
Number of Branches	12.95	16	10.01	13	8.77	11
Number of Pods	7.92	11	6.03	10	5.42	8
Weight of Pods	7.95	12	5.97	10	6.37	6
Weight of 100 seed	2.33	9	1.95	5	1.97	3
Seed Yield/plant	8.21	11	6.17	9	5.50	7

Finally, it can be concluded that the reduction in the magnitude of differences that could be detecied with increasing sample size was less than that obtained by equivalent increase in number of replications.

These results conforms with the previous findings obtained by Khalit *et al.* (1970), Hanna (1972) and Hack (1976).

The reseach worker has a considerable range in selecting sample size and replications of plots, depending an the amount of land under his disposal. Where the amount of land is not limited, the use of 4 to 6 replications and mean sample units between (3 to 13) would be satisfactory to obtain reasonable accuracy. In cases where only small amount of land is avallable, the use of two replications with mean sample units between (9 to 16) would be used to give the same accuracy that would result in more efficient use of the land.

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تقدير أنسب مساحة للقطعة التجريبية وعدد المكررات وعدد العينات لمحصول الفول البلدى

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أجرى هذا البحث لدراسة أنسب مساحة للقطعة التجريبية وأنسب عدد من المكررات والعينات في تجارب خاصة بمحصول الفول البلدى أقيمت هذه التجربة بمحطة بحوث سدس خلال موسمى ٢٠٠٢ /٢٠٠٣و٢٠٠٣ /٢٠٠٤ و قد إشتملت التجربة على ٧ أصناف من الفول البلدى المنزرع فى تصميم قطاعات كاملة العشوائية فى ثلاث مكررات.

أتبع فى الدراسة طريقتان إحصائيتان لتقدير أنسب مساحة للقطعة التجريبية:

الطريقة الأولى: هى طريقة سميث التى تعتمد أساسا على العلاقة الخطية بين لوغارتم مساحة القطع ولوغارتم التباين لوحدة المساحة.

الطريقة الثانية: هى طريقة أقصى إنحناء والتى تعتمد على تقدير العلاقة الأسية بين مساحة القطع التجريبية ومعامل الإختلاف.

ويمكن تلخيص أهم النتائج المحتصل عليها فيما يلى:

١- أدت زيادة مساحة القطع التجريبية إلى تناقص التباين لوحدة المساحة وكذا معامل الإختلاف إلا أن النقص لم يكن متناسب مع الزيادة فى مساحة القطع.

٢- كانت قيم دليل عدم تجانس التربة –٠,٥١٢ فى الموسم الأول –٠,٨٠٧ فى الموسم الثانى متوسط –٠,٦٦٠

٣- أمكن وضع العلاقة بين معامل الإختلاف (خ) ومساحة القطعة التجريبية (س) فـــى صـــورة رياضية بالمعادلة الأتية:

خ = ١٨,٢٩٣ س – ٠,٦٢٤ للموسم الأول

خ = ١٦,٣١٨ س – ٠,٨٦٠ للموسم الثانى.

٤- أتبع طريقتين لحساب أنسب مساحة للقطعة التجريبية :

أ- طريقة سميث : وقد اوضحت النتائج ان انسب مساحة للقطعـــة التجريبيـــة كانـــت ٢,٤٤١ م٢ للموسم الاول ٣,٢١٨ م٢ للموسم الثانى

ب_طريقة أقصى إنحناء : وقد اوضحت النتائج ان انسب مساحة للقطعة التجريبيـــة كانـــت ١٣,٣٤٢ م٢ للموسم الاول ١٧,٦٤٨ م٢ للموسم الثانى

٥- لوحظ أن النقص الحادث فى التباين يكون أقل بزيادة العينات عـــن زيـــادة مســـاحة القطـــع التجريبية.

٦- إنخفضت قيمة الخطأ التباين لجميع الصفات المدروسة بزيادة العينات والمكررات.

٧- لوحظ أن زيادة عدد المكررات كان أكثر كفاءة من زيادة عدد النباتات داخل المكـــرر حتـــى يمكن تحديد فروق مقدارها ١٠% من محصول الفول ومكوناته.

٨- اشارت النتائج أيضاً إلى أن العدد الأمثل من العينات قد أختلف من صفة لأخـــرى وأن هـــذا العدد يعتمد بشكل أساس على طبيعة التباين للصفة المدروسة.