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INCREASING PRECISION OF FIELD EXPERIMENTS IN MAIZE USING UNIFORMITY TRIALS

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ABSTRACT

The present study aimed to find out optimum plot size, shape and the proper number of replications in maize experiments. Two uniformity trials were carried out at the Agricultural Research Station of Sids, Beni-Sowef Governorate during the successive growing seasons of 2002 and 2003 using maize cultivar Three Way Cross 310 (T.W.C 310). The actual area of each field trial was divided into 8 strips, each consisted of 100 rows of 3.0 m long and 70 cm apart. Each row was considered as a basic unit *i.e* 2.1 m^2. Consequently, a total of 800 basic units was utilized for each trial in the two seasons. Optimum plot size was estimated using Smith method and maximum curvature procedure.

Increasing plot size decreased variance per basic unit and C.V. However, the reduction was not in proportion with the increase in plot size. Index of soil heterogeneity was 0.5430 and 0.6679 for the first and second seasons, reppectively, indicating moderate variation in the soil.

Increasing plot size from one basic unit to 400 basic units reduced C.V from 20.187 to 4.925 respectively, in the first season and correspondingly from 26.731 for one basic unit plot size to 3.582 for a plot size of 400 basic units in the second season. The exponential relationships between C.V and plot size (X) were C.V = $20.187X^{-0.235}$ and C.V = $26.731X^{-0.335}$ for the first and second seasons, repectively. Optimum plot size was one and two basic units (1/2000 and 1/1000 fed) for both seasons, respectively, using Smith method while it was 3 and 5 basic units (1/667 and 1/400 fed) using maximum curvature method.

Plot shape had no clear effect in all cases. However, long and narrow plots were more efficient as it decreased variance per basic unit and C.V. Increasing plot size generally decreased number of replications required to detect differences of 15 % and 20 % of the mean.

INTRODUCTION

The precision of the field trials depends considerably on the experimental design and soil variability. Soil heterogeneity has been recognized as a major factor affecting the sensivity of the experiment 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 choosing an appropriate design and using an optimum plot size and shape as well as number of replications which, in turn, affect the precision of field experiments (Gomez and Gomez, 1984). Determining optimum plot size, shape and number of replications provides useful information to minimize the error variance and the cost of handling the plot. Such information would help agronomists and plant breeders in planning more efficient experiments to attain desirable precision.

Shehata *et al* (1974), working on maize in Egypt, reported that coefficient of variability decreased from 12.9 to 5.9 % as plot size increased from one row plot to eight rows plot and was more sensitive to the number of replications than to the number of plants.

Results of Wassouf (1977) indicated that the optimum plot size, estimated using the modified method reported by Hatheway (1961), ranged from 4.91 m^2 to 7.03 m^2. When the comparable variance method was practiced, the optimum size of plot was 19.3 m^2. Furthermore, he concluded that values of variance per basic unit, coefficient of variability and standard error decreased as the plot size increased. He found also that five replications were suitable for corn trials. Increasing number of replications decreased the standard error more rapidly than increasing plot size.

Values of soil heterogeneity index were 0.80 and 0.85 in corn trials conducted by El-Rassas (1982). Coefficient of variation decreased by increasing plot size from one basic unit to 300 basic units. The optimum plot size ranged from 4 to 8 basic units (1/300 to 1/150 fed) including two border rows. He found that long and narrow plots were more effective in reducing variance per basic unit area, comparable variance and coefficient of variation. A plot size of 4 to 6 basic units and 6 to 8 replications were recommended for corn yield trials.

Using thirty nine corn yield trials, Galal *et al* (1985) studied the soil heterogeneity and convenient plot size. The results indicated that increasing number of replications reduced soil variability index and coefficient of variability.

The objectives of the current investigation were to determine the soil variability index, optimum plot size, shape and number of replications in maize trials.

MATERIALS AND METHODS

Two uniformity trials were carried out at the Agricultural Research Station of Sids, Beni-Sowef Governorate during the successive growing seasons of 2002 and 2003 using maize cultivar Three Way Cross 310 (T.W.C 310). The study was designed to find out optimum plot size, shape and the proper number of replications in maize experiments.

The actual area of each field trial was divided into 8 strips, each consisted of 100 rows of 3.0 m long and 70 cm apart. Each row was considered as a basic unit *i.e* 2.1 m^2. Consequently, a total of 800 basic units was utilized for each trial in the two seasons. The distance between hills was 25 cm. Sowing was done on June 14th and 24th for first and second seasons, respectively. The cultural practices were carried out as commonly adopted in maize fields. Plants of each basic unit were harvested, shelled separately, then the grains were weighted to the nearest gram after adjusting moisture content in the grains to 15.5 %.

Statistical analysis:

Data collected from each uniformity trial were analyzed to estimate the soil heterogeneity index (b), the effect of plot size and shape on the variance per basic unit area (Vx), comparable variance (V), coefficient of variability (C.V) and number of replications (r). Before carrying out the statistical analysis, data were arranged in sequence. There were 32 plot combinations ranging from 1 to 400 basic units and covering a broad variety of plot shapes, (Table 1). Number of plots was calculated by dividing the total number of basic units (800 units) by the number of basic units for each plot size.

1-Optimum plot size:

Optimum plot size was determined following two procedures:

1- 1-Smith method:

The index of soil variability, b, proposed by Smith (1938) was estimated from the empirical relationships between plot size and variance per basic unit. This relationship may be expressed in logarithmic form as:

$$\text{Log } V_x = \text{Log } V_1 - b \log X$$

Where:

V_x: is the variance per basic unit calculated as among plot variance $V_{(x)}$ divided by the square of its size in basic units X,

$$V_x = V_{(x)} / X^2$$

V_1 : is the variance of plots of one basic unit, and

B : is the regression coefficient which is a measure of correlation between adjacent basic units.

b can be estimated, from this equation, as a linear regression coefficient. Smith (1938) suggested using simple weighting of variances by their respective degrees of freedom to calculate b. Kock and Rigney (1951) and Hatheway and Williams (1958) reported that a simple weighting of variances is not accurate because of high correlation among adjacent plots. Federer (1955) recommended the following equation to calculate b:

$$b = \frac{\left(\sum W_i \log V_{X_i} \log x_i\right) - \dfrac{\left(\sum W_i \log V_{X_i}\right)\left(\sum W_i \log X_i\right)}{\left(\sum W_i\right)}}{\sum W_i (\log x_i)^2 - \dfrac{\left(\sum W_i \log X_i\right)^2}{\left(\sum W_i\right)}}$$

Where:

b = weighted index of soil variability,

W*i* = degrees of freedom associated with V*xi*,

V*xi* = weighted variance per basic unit of the *ith* plot size, and

X*i* = number of basic units in the *ith* plot size.

Smith used this index in conjunction with the estimates of cost factors to determine the optimum plot size. However, Hatheway (1961) pointed out that, in research, scientists are generally more interested in designing experiments that are able to dectect difference of specified size ignoring cost factors. Therefore, the optimum plot size was calculated from the formula:

$X_{opt} = b / (1-b)$

Table 1: Variance and coefficient of variability of different plot sizes and shapes for 32 combinations from 800 basic units of maize in 2002 and 2003 Seasons.

Serial Number	Plot size and shape			Plot dimensions (m) Width X Length	Plot area		Total number of plots	2002 Season			2003 Season		
	Number of basic units							Variance		Coefficient of variability C.V.%	Variance		Coefficient of variability C.V.%
	Size	Rows	Strips		M^2	Feddan		Per basic Units V_{xi}	Among plots (V_{xi})		Per basic Units V_{xi}	Among plots (V_{xi})	
1	1	1	1	0.7 X 3.0	2.1	1/2000	800	0.1664	0.1664	22.724	0.3308	0.3308	27.077
2	2	1	2	0.7 X 6.0	4.2	1/1000	400	0.0903	0.3614	16.745	0.1841	0.7363	20.200
3	2	2	1	1.4 X 3.0	4.2	1/1000	400	0.1034	0.4137	17.918	0.2001	0.8004	21.060
4	4	1	4	0.7 X 12.0	8.4	1/500	200	0.0585	0.9363	13.477	0.1153	1.8452	15.988
5	4	2	2	1.4 X 6.0	8.4	1/500	200	0.0559	0.8946	13.174	0.1106	1.7697	15.658
6	4	4	1	2.8 X 3.0	8.4	1/500	200	0.0790	1.2643	15.661	0.1153	1.8446	15.986
7	5	5	1	3.5 X 3.0	10.5	1/400	160	0.0753	1.8828	15.289	0.1105	2.7619	15.648
8	8	1	8	0.7 X 24.0	16.8	1/250	100	0.0286	1.8315	9.425	0.0532	3.4054	10.860
9	8	2	4	1.4 X 12.0	16.8	1/250	100	0.0405	2.5899	11.207	0.0745	4.7656	12.847
10	8	4	2	2.8 X 6.0	16.8	1/250	100	0.0442	2.8309	11.717	0.0670	4.2876	12.186
11	10	5	2	3.5 X 6.0	21.0	1/200	80	0.0421	4.2127	11.435	0.0633	6.3346	11.850
12	10	10	1	7.0 X 3.0	21.0	1/200	80	0.0602	6.0195	13.669	0.0825	8.2527	13.525
13	16	2	8	1.4 X 24.0	33.6	1/125	50	0.0197	5.0450	7.821	0.0293	7.4884	8.052
14	16	4	4	2.8 X 12.0	33.6	1/125	50	0.0327	8.3689	10.073	0.0483	12.3559	10.343
15	20	5	4	3.5 X 12.0	42.0	1/100	40	0.0311	12.4308	9.821	0.0480	19.1823	10.310
16	20	10	2	7.0 X 6.0	42.0	1/100	40	0.0334	13.3612	10.182	0.0475	18.9880	10.258
17	20	20	1	14.0 X 3.0	42.0	1/100	40	0.0507	20.2811	12.545	0.0704	28.1496	12.490
18	25	25	1	17.5 X 3.0	52.5	1/80	32	0.0465	29.0469	12.010	0.0631	39.4529	11.829
19	32	4	8	2.8 X 24.0	67.2	1/62.5	25	0.0155	15.8486	6.931	0.0128	13.0859	5.322
20	40	5	8	3.5 X 24.0	84.0	1/50	20	0.0142	22.6563	6.630	0.0129	20.6234	5.345
21	40	10	4	7.0 X 12.0	84.0	1/50	20	0.0255	40.7599	8.892	0.0417	66.6924	9.612
22	40	20	2	14.0 X 6.0	84.0	1/50	20	0.0276	44.1320	9.253	0.0398	63.6809	9.393
23	50	25	2	17.5 X 6.0	105.0	1/40	16	0.0244	61.0516	8.706	0.0383	95.8240	9.217
24	50	50	1	35.0 X 3.0	105.0	1/40	16	0.0440	109.9656	11.684	0.0513	128.3271	10.667
25	80	10	8	7.0 X 24.0	168.0	1/25	10	0.0099	63.5642	5.552	0.0102	65.0972	4.748
26	80	20	4	14.0 X 12.0	168.0	1/25	10	0.0220	140.4844	8.254	0.0368	235.8160	9.037
27	100	25	4	17.5 X 12.0	210.0	1/20	8	0.0206	205.5245	7.987	0.0351	350.9732	8.820
28	100	50	2	35.0 X 6.0	210.0	1/20	8	0.0236	235.5335	8.550	0.0312	312.2098	8.319
29	160	20	8	14.0 X 24.0	336.0	1/12.5	5	0.0066	169.0938	4.528	0.0045	114.8125	3.153
30	200	25	8	17.5 X 24.0	420.0	1/10	4	0.0057	226.5938	4.193	0.0026	103.8542	2.399
31	200	50	4	35.0 X 12.0	420.0	1/10	4	0.0224	897.5729	8.346	0.0341	1364.708	8.696
32	400	50	8	35.0 X 24.0	840.0	1/5	2	0.0069	1096.500	4.612	0.0018	285.2500	1.988

1-2- Maximum curvature procedure:

The second method used was the maximum curvature approach which was modified by Lessman and Atkins (1963), Meier and Lessman (1971) and Galal and Abou-El-Fittouh (1971).

The point of maximum curvature, X_o for the exponential curve, $C.V = AX^{-B}$ relating the coefficient of variability (C.V) and plot size (X) was determined using the following equation:

$X_o = [A^2 B^2 (2B + 1) / (B + 2)]^{1/(2B+2)}$

Using the principles of linear regression, values of A and B were estimated as follows:

$$B = \frac{n\sum \log(C.V)\log X - \sum \log(C.V)\sum \log X}{n\sum(\log X)^2 - \left(\sum \log X\right)^2}$$

$$\text{Log } A = \frac{\sum \log(C.V.)}{n} - B\frac{\sum \log X}{n}$$

Then the equation used to detrermine X_o was converted to logarithmic form as follows :

$$\text{Log } X_0 = \frac{2\log A + 2\log B + \log(2B+1) - \log(B+2)}{(2B+2)}$$

Plot size directly beyond the X_o value on the curve is considered optimum. Also, cost estimates were not considered in this method.

2- Optimum plot shape:

To study the effect of plot shape, differences among plot shapes compossed of the same number of basic units were tested for significance by comparing their variances through Bartelett Chi square test for homogeneity of variances as outlined by Steel and Torrie (1980).

3- Optimum number of replications:

Several methods can be used to determine the required number of replications, based on the coefficient of variation, to detect a specified percentage difference between treatment means. A commonly used method, based on students t statistic, was given by Federer (1955). The number of replications of different plot sizes for the two trials was calculated according to the following formula:

$$r = \frac{2\,t^2\alpha\,(C.V.)^2}{D^2}$$

Where:

t : is the value of students t at the level of significance for degrees of freedom associated with the C.V,

α : is the significance level,
C.V : is the coefficient of variability,
D : is the minimum difference to be detected expressed as percentage of the mean, and
r : is the number of replications.

RESULTS AND DISCUSSION

Table 1 show variance per basic unit area, among plots and C.V for 32 combinations of plot size and shape for first and second seasons, respectivly. Two procedures namely: Smith method and maximum curvature method were used to estimate the optimum plot size for maize trials grown at Sids region in the seasons of 2002 and 2003.

1- Smith method:

The following estimates were calculated using Smith method to determine the optimum plot size for each experiment:

1-1-Variance per basic unit area and among plots:

Results in Table 1 clear that variance per basic unit area generally decreased with the increase in plot size. Variance per basic unit area in the 2002 season decreased from 0.1664 for the smallest plot size (one basic unit) to 0.0057 for the plot size of 200 basic units. In the season of 2003, variance per basic unit decreased from 0.3308 for a plot size of one basic unit to 0.0018 for a 400 basic units plot size. On the other hand, increasing plot size increased variance among plots that reached its maximum by increasing plot size from one basic unit to 400 basic units in the first season and 200 basic units in the second season.

1-2- Index of soil variability:

The weighted index of soil variability (b) as proposed by Federer (1955) was found to be 0.5430 in the first season and 0.6679 for the second season. The coefficient of soil heterogeneity (b) is a reflection of correlation between adjacent plots and is expected to vary between zero to one. The value near zero denotes complete uniformity in soil, but the value near one denotes random soil variability. Thus, the obtained values of soil variability index in both seasons reflect moderate variability in the soil of the experiment at Sids region.

1-3- Optimum plot size:

Soil variability index and optimum plot size as estimated by Smith method are shwon in Table 2. Values of soil variability index (b) were used in calculating the optimum plot size which was found to be 1.1882 and 2.0114 basic units in the first and second trials, respectively. Consequently, it could be concluded that the optimum plot size was one basic unit being 2.1 m^2 (1/2000 feddan) in the 2002 season while it was two basic units being 4.2 m^2 (1/1000 feddan) for the 2003 season.

Table 2: Optimum plot size estimated using Smith method for maize cultivar T.W.C 310 grown at Sids region in 2002 and 2003 seasons.

Seasons	B	Optimum plot size		
		Basic unit	Area	
			M^2	Feddan
2002	0.5430	1	2.1	1/2000
2003	0.6679	2	4.2	1/1000

2- Maximum curvature method:

Estimates of coefficient of variation of yield for different plot sizes in the two seasons of 2002 and 2003 are presented in Table 3. The results revealed that values of coefficient of variation generally decreased as plot size increased. Coefficient of variation decreased from 20.19 for one basic unit plot size to 4.93 for a plot size of 400 basic units in the first season and correspondingly from 26.73 for a plot size of one basic unit to 3.58 for a 400 basic units plot size.

Results in Table 3 obviously indicated that increasing plot size decreased the variance per basic unit area and coefficient of variability. However, the reduction was not in proportion with the increase in the plot size. Moreover, the rate of reduction decreased as the plot became larger. This confirms the fact that the relationship between plot size and the variance per basic unit or the coefficient of variation is exponential in nature.

The exponential relationships obtained for the current study were $C.V= 20.187X^{-0.235}$ and $C.V= 26.731\ X^{-0.335}$ for first and second seasons, respectively, where X is the size of plot. Figures 1 and 2 illustrat graphically these relationships.

Table 3: Average variance per basic unit (Vx), average yield (Y) and average coefficient of variability (C.V) for each plot size for maize trials in 2002 and 2003 seasons.

Plot Size	No.of plots	2002 season				2003 season			
		V_x	Y (gm)	C.V		V_x	Y (gm)	C.V	
				Observed	Estimated			Obsrved	Estimated
1	800	0.1664	1.79	22.724	20.187	0.3308	2.12	27.077	26.731
2	400	0.0969	3.59	17.332	17.147	0.1921	4.25	20.630	21.185
4	200	0.0645	7.18	14.104	14.565	0.1137	8.50	15.877	16.790
5	160	0.0753	8.97	15.289	13.820	0.1105	10.60	15.648	15.579
8	100	0.0377	14.36	10.783	12.372	0.0649	16.99	11.964	13.307
10	80	0.0512	17.95	12.552	11.739	0.0729	21.24	12.688	12.347
16	50	0.0262	28.72	8.947	10.509	0.0388	33.98	9.198	10.546
20	40	0.0384	35.90	10.849	9.971	0.0553	42.48	11.019	9.786
25	32	0.0465	44.87	12.010	9.461	0.0631	53.10	11.829	9.080
32	25	0.0155	57.44	6.931	8.927	0.0128	67.97	5.322	8.358
40	20	0.0224	71.80	8.258	8.470	0.0315	84.96	8.117	7.756
50	16	0.0342	89.75	10.195	8.036	0.0448	106.20	9.942	7.196
80	10	0.0160	143.60	6.903	7.195	0.0235	169.92	6.893	6.147
100	8	0.0221	179.49	8.269	6.826	0.0332	212.40	8.570	5.703
160	5	0.0066	287.19	4.528	6.111	0.0045	339.84	3.153	4.871
200	4	0.0141	358.99	6.270	5.798	0.0184	424.81	5.548	4.520
400	2	0.0069	717.97	4.612	4.925	0.0018	849.61	1.988	3.582

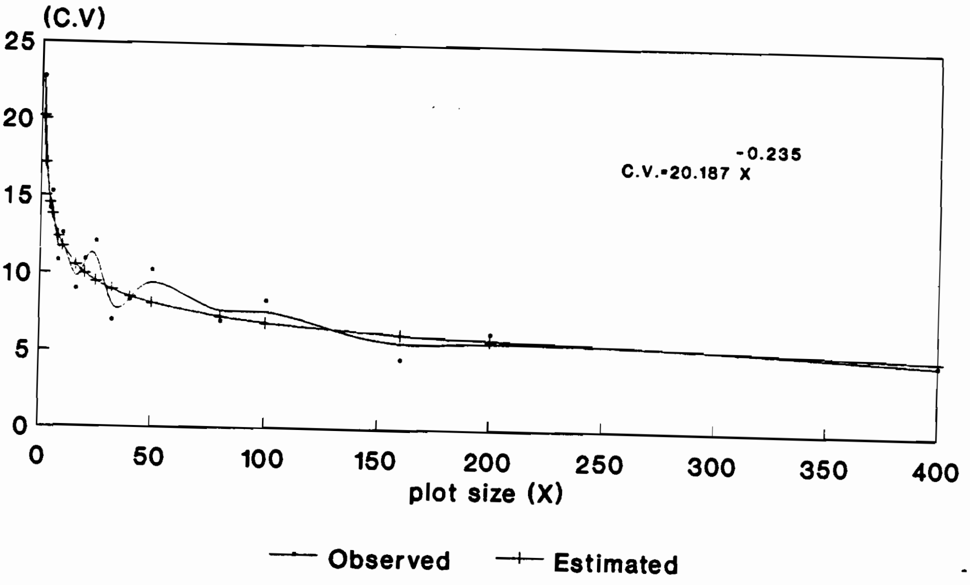

Fig.1:Relationship between plot size (x) and coefficient of variation (c.v) in maize in the season of 2002.

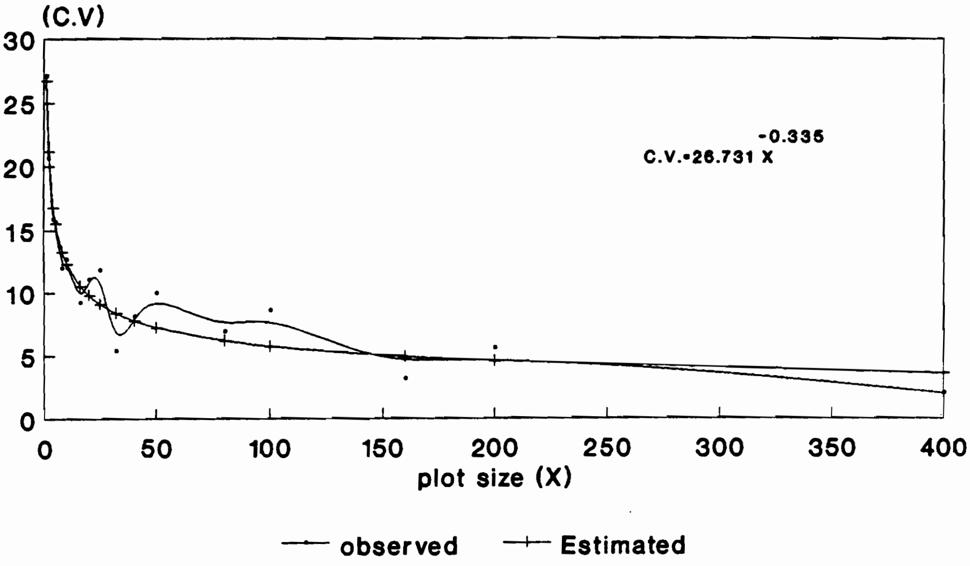

Fig.2:Relationship between plot size (x) and cofficient of variation (C.V) in maize in the season of 2003.

According to the maximum curvature method, the coefficient of variation was used as an indicator to optimum plot size and it is graphed on the Y axis in relation to various plot sizes on X axis (Figs 1 and 2). Consequently, the optimum plot size is considered to be the point on the curve where the rate of change for the estimate of Y per increase of X greatest; so called " the maximum curvature ". The point of maximun curvature was 3.45 and 7.82 in the first and second seasons, respectively. The optimum plot size was 3 basic units, for the first season, being 6.3 m^2 or 1/667 feddan while it was 5 basic units in the second season being 10.5 m^2 or 1/400 feddan, (Table 4).

Generally, the estimated optimum plot size is always affected by several factors that might cause extreme fluctuations such as crop, location, agricultural practices, size of performed basic unit and statistical technique utilized for calculating such optimum size of plot.

Table 4: Optimum plot size estimated using maximum curvature method for maize cultivar T.W.C 310 grown at Sids region in 2002 and 2003 seasons.

Seasons	A	B	Optimum plot size		
			Basic unit	Area	
				M^2	Feddan
2002	20.187	0.235	3	6.3	1/667
2003	26.731	0.335	5	10.5	1/400

Several investigators have obtained similar results varying according to one or more of above mentioned factors such as El-Kalla and Gomaa (1977) (1/1400 to 1/840 fed in wheat), El-Rassas (1982) (1/250 to 1/166.7 fed in corn), Aly (1983) (1/560 fed in sesame), Nasrallah (1988) (1/291.7 fed in upland cotton), Abd El-Halim *et al* (1989) (1/3500 to 1/875 fed in faba bean), Casler and Tageldin (1996) (1.4 m^2 in orchardgrass), Salem and Salama (2001) (1/262.5 to 1/70.8 fed in wheat) and Ashmawy *et al* (2003) (1/1500 fed in wheat).

3- Plot shape:

Results of Bartlett test for the homogeneity of variances for 2002 and 2003 seasons are displayed in Table 5. The results clearly indicated that the variances of different shapes of plot did not significantly vary for all cases in the two seasons, indicating that the plot shape had no important effect.

Results presented in Table 1 cleared that coefficient of variability decreased as plot size increased and that increasing the number of strips for a fixed plot size reduced coefficient of variation more effectively than increasing number of rows. Refering to the results in Table 1 and comparing different shapes for specified size, it could be concluded that a long and narrow shape is generally more efficient compared with other shapes. This is clear from its low variance per basic unit area and coefficient of variability.

Table 5: Results of Bartlett test for the homogeneity of variances for maize trials in 2002 and 2003 seasons.

Plot size	Value of Chi-square	
	2002 season	2003 season
2	1.8230	0.6957
4	7.2158	0.1139
8	4.9883	2.8380
10	2.5184	1.3866
16	3.1371	3.0718
20	2.7816	2.0032
40	2.2529	6.8976
50	1.3242	0.3297
80	1.4598	3.6992
100	0.0349	0.0258
200	1.5660	4.7506

4- Number of replications:

Results of number of replications required to detect differences of 15 % and 20 % between treatment means are shown in Table 6. In the first season, number of replications required to detect 15 % difference between treatment means decreased from 14 for a plot size of one basic unit to 2 for 100 basic unit plot size. For detecting a 20 % difference, number of replicates varied from 8 for a plot size of one basic unit to one replicate with a plot size of 100 basic units.

In the second season, number of replications required to detect 15 % difference decreased from 24 replicates for one basic unit plot size to two replications for plot size of 100 basic units. To detect a 20 % difference, number of replicates decreased from 14 with a plot size of one basic unit to one replicate with 100-basic unit plot size.

Table 6: Number of replications required to detect differences of 15 % and 20 % between treatment means at the 5 % level of significance for maize in 2002 and 2003 seasons.

Plot size		2002 season		2003 season	
Number of basic units	Area (M^2)	Number of replications		Number of replications	
		15 % difference	20 % difference	15 % difference	20 % difference
1	2.1	14	8	24	14
2	4.2	10	6	15	9
4	8.4	7	4	10	5
5	10.5	7	4	8	5
8	16.8	5	3	6	3
10	21.0	5	3	5	3
16	33.6	4	2	4	2
20	42.0	4	2	3	2
25	52.5	3	2	3	2
32	67.5	3	2	3	1
40	84.0	3	2	2	1
50	105.0	3	1	2	1
80	168.0	2	1	2	1
100	210.0	2	1	2	1

Number of replications required to detect differences of 15 % and 20 % of the mean generally decreased with the increase in plot size, but the reduction was not in proportion with the increase in plot size. The results cleared that the highest number of replications was required for the plot size of one basic unit.

Results of both seasons clear that increasing number of replications and plot size decreased the standard error. The rate of the decrease was more rapidly by increasing number of replications than increasing plot size.

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زيادة دقة التجارب الحقلية فى الذرة الشامية باستخدام تجارب التجانس

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المعمل المركزى لبحوث التصميم والتحليل الاحصائى – مركز البحوث الزراعية

تهدف هذه الدراسة الى تقدير أنسب مساحة وشكل للقطعة التجريبيه وأفضل عدد للمكررات وتأثير ذلك على دقة التجارب الزراعية فى محصول الذرة الشامية. أقيمت لهذا الغرض تجربتى تجانس فى محطة البحوث الزراعية بسدس محافظة بنى سويف فى موسمى ٢٠٠٢ و ٢٠٠٣ باستخدام صنف الذرة الشامية هجين ثلاثى ٣١٠.

أظهرت النتائج أن زيادة مساحة القطعة التجريبية أدت إلى إنخفاض التباين لوحدة المساحة ومعامل الأختلاف ولكن معدل الأنخفاض لايتناسب مع زيادة مساحة القطعة التجريبيه. تراوحت قيمة دليل تجانس التربة بين ٠,٥٤٣٠ و ٠,٦٦٧٩ والتى تدل على أن درجة تجانس التربه فى حقول الذرة الشامية فى منطقة سدس متوسطة.

أوضحت النتائج ايضا أن زيادة مساحة القطعة التجريبية أدت الى انخفاض قيمة معامل الاختلاف. و كانت أنسب مساحة للقطعة التجريبيه ١/٢٠٠٠ من الفدان (٢,١ م٢) ، ١/١٠٠٠ من الفدان (٤,٢ م٢) للموسمين الأول والثانى على الترتيب باستخدام طريقة Smith بينما تراوحت من ١/٦٦٧من الفدان (٦,٣ م٢) إلى ١/٤٠٠ من الفدان (١٠,٥ م٢) فى الموسمين باستخدام طريقة maximum curvature. و لم يكن لشكل القطعة تأثيرا واضحا فى كل الحالات تحت الدراسة ولكن لوحظ أن القطع المستطيله الضيقه كانت أكثر كفاءة حيث أنها تقلل التباين ومعامل الاختلاف بالقطعة التجريبيه.

أشارت النتائج الى أن زيادة عدد المكررات أثرت تأثيرا واضحا على دقة التجربه نتيجة إنخفاض معامل الاختلاف حيث كانت زيادة عدد المكررات أكثر كفاءة من زيادة مساحة القطعة التجريبيه.