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FIELD PLOT TECHNIQUE IN EVALUATING MAIZE GENOTYPES UNDER DROUGHT CONDITIONS

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ABSTRACT

Maize (*Zea mays* L.) is one of the most important basic cereal crops in the world. In Egypt , Maize was grown in about 1.975.400 million faddans in 2004 and produced about 20.97 ardab / Fadden (one Fadden = 4200 m² and one ardab = 140 kg) (Report by FAO 2004).

Maize crop is known to be sensitive to available soil moisture especially during reproductive stage therefore yield decrease resulting from soil moisture deficit depends upon numerous factors, such as the growth stage at which the moisture deficit develops, the severity and duration of water deficiency, and the susceptibility of the examined genotype (*Denmead and Shaw, 1960 Lorens et al., 1987*) .According to the difference in conditions, like irrigation, it is more important to study and recommend plot size in controlled irrigation treatment and drought treatment besides the field plot technique dealing with various factors essential for a properly planned Agriculture field experiment. some of these factors are size , shape, and arrangement of plots as experimental units together with the effects of these units on each other

MATERIALS AND METHODS

The present investigation was carried out at the Agric. Exp. Stat. Of Cairo University during 2002 and 2003 seasons.

The experiment was sown in a split plot design with four replications during two seasons , 2002 and 2003 . Water treatments occupied the main plots. Each replication consisted of 68 rows , 34 rows for each genotype as well as each water treatment. Each row is 6m long and 70cm .apart (i.e. plot size was 4.2m^2)

All recommended practices were conducted as commonly adopted in farmer's field in the district except irrigation was evaluated under two water supply treatments as follows :

1-Conventional treatment : in which the first irrigation was applied 21 days after sowing , then the other five irrigations were applied at 15 days interval as recommended for maize production at Giza .

2-Stress treatment : by skipping the fourth , fifth and sixth irrigation (75 days from planting).

Plants from each ridge which is considered as basic unit (6 m long and 70 cm Wide) were hand harvested , ears were husked , dried to reach uniform moisture content in grains (15.5%) at time of weighting.

The statistical procedures used were :

1- Optimum plot size :

Computations were carried out on electronic facilities of the Center Laboratory for Designs and Statistical Analysis (Galal and Abou- Elfittouh 1971)

1-Two principle methods to estimate optimum plot size were used :

a- *Maximum curvature methods (Federer (1955))*

b-Comparable variance method :(Keller (1949))

2-Plot shape:

To study the effect of plot shape differences among plot shapes composed of the same number of basic units were tested for significance by comparing their variances (V_x) through Bartlett's Chi Square test for homogeneity of variances as given by Steel and Torrie (1960) .

3 - Optimum number of replications :

Hayes, Immer and Smith (1955) were used to determine the theoretical number of replications necessary to bring down the coefficient of variation 5 % of the mean .This equation is : $r = (C.V./d)^2$

where:

r = the theoretical number of replications .

$C.V.$ = the coefficient of variability .

d = the magnitude value of treatment differences measured as percentage of the mean and reported that increasing number of replicates decreased the standard error values (S_x) than increasing plot size therefore analysis of variance was used in this study to estimate standard errors for five different plot sizes and wide range of replications from 2 to 10 to reach this status .

Standard error $(Sx) = S/\sqrt{n}$

Where:

S = standard deviation .

n = number of replications .

RESULTS AND DISCUSSION

Optimum plot size :

The experiment included Two genotypes (G.2 and S.C.10) divided into 8 experiments:

1- G.2 in control 2002 season . G.2 in control 2003 season.
2- G.2 in stress 2002 season. G.2 in stress 2003 season.
3- S.C 10 in control 2002 season. S.C 10 in control 2003 season.
4- S.C 10 in stress 2002 season. S.C 10 in stress 2003 season.

and each experiment included one genotype and one irrigation treatment.

G.2 in control and stress irrigation treatment for 2002 and 2003 seasons:

1- Maximum curvature Method:

Data presented in Table 1 indicated that the total yield per basic unit (70 cm x 6 m = 4.2 m^2) ranged from 1.28 to 2.53 kg. with an average of 1.91 kg for 2002 control treatment meanwhile 2003 control treatment ranged from 0.89 to 2.17 kg . with an average of 1.53kg otherwise stress treatment for 2002 season total yield per basic unit ranged from 0.55 to 2.08 kg. with an average of 1.32kg and for stress treatment 2003 season ranged from 0.48 to 1.92 kg . with an average of 1.2 kg.

Table(1): Maize yield in (kg) for each basic unit one row in four strips in uniformity trials of 2002 and 2003 for Giza 2 :

Strip Row	Control								Stress							
	2002				2003				2002				2003			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	1.59	2.34	1.89	1.64	1.65	1.61	1.70	1.18	1.15	1.95	1.67	1.48	1.37	1.87	1.66	1.75
2	1.47	2.15	1.46	1.56	1.65	1.91	1.69	1.15	1.03	1.55	0.95	1.15	0.85	0.70	1.71	1.81
3	1.59	2.06	1.73	1.82	1.55	1.92	1.28	1.02	0.93	1.48	1.01	1.53	0.78	0.86	1.69	1.80
4	1.64	2.29	1.58	2.19	1.60	2.15	1.51	1.12	1.15	1.70	1.09	1.26	0.92	0.93	1.35	1.33
5	1.72	2.12	1.63	2.04	1.48	1.99	1.56	1.18	0.87	1.84	1.13	1.17	0.82	0.81	0.61	0.54
6	1.52	1.79	1.60	1.82	1.56	1.73	2.03	1.15	1.09	1.83	0.94	0.63	0.64	0.99	1.15	0.48
7	1.45	2.01	1.59	1.92	1.42	1.91	1.79	1.14	1.12	1.72	1.23	0.65	0.71	1.28	1.33	1.09
8	1.79	2.27	1.76	2.14	1.91	2.13	1.87	1.64	0.94	1.51	1.05	0.55	0.99	0.70	1.71	1.81
9	1.63	2.02	2.29	1.69	1.75	1.48	1.68	1.12	1.29	1.55	1.29	1.09	0.75	0.86	1.65	1.80
10	1.33	2.07	2.16	1.35	1.56	2.00	1.38	1.03	1.09	1.81	1.15	1.03	1.02	0.93	1.66	1.33
11	1.56	2.39	2.19	1.73	2.02	1.91	1.39	1.09	0.99	1.56	1.82	0.89	0.78	0.81	0.77	0.54
12	1.59	2.42	1.65	2.25	1.78	2.15	1.45	1.51	1.28	1.88	1.98	1.15	0.99	0.99	0.94	0.56
13	1.75	2.10	1.39	2.00	2.12	1.65	1.99	1.36	1.11	1.67	1.18	0.83	0.84	1.03	1.23	0.95
14	1.68	1.88	1.97	1.94	1.46	1.91	1.97	0.89	1.35	1.36	0.71	1.09	1.03	0.93	1.73	0.75
15	1.73	2.05	2.02	1.76	1.55	1.92	1.83	1.37	1.19	1.25	1.67	1.07	0.53	0.83	1.92	1.75
16	1.28	1.71	2.29	2.27	1.49	2.15	1.62	1.02	0.93	0.99	1.19	0.99	0.98	0.93	1.05	1.81
17	1.33	1.54	2.32	2.17	1.58	1.99	1.38	1.19	1.04	1.58	1.58	1.19	0.69	0.81	1.35	1.80
18	1.51	1.69	2.05	1.99	2.17	1.73	1.81	0.89	1.19	1.91	1.00	1.09	0.81	0.92	0.81	0.97
19	1.89	1.55	2.21	2.07	1.87	1.91	1.89	1.37	0.89	1.81	1.82	0.99	0.90	1.19	1.68	1.33
20	2.33	1.79	2.08	1.74	1.79	2.13	1.84	1.21	1.69	1.77	1.49	1.23	0.91	1.23	1.64	0.54
21	1.90	1.63	1.95	1.35	1.39	1.48	1.86	1.61	0.89	1.39	1.89	1.05	0.76	0.87	1.72	0.48
22	2.31	1.57	1.89	1.49	1.48	2.00	1.56	1.52	1.02	1.69	1.60	1.29	0.98	0.99	1.15	1.09
23	1.99	1.70	1.53	1.73	1.55	1.91	1.28	1.34	1.03	1.82	1.47	1.19	1.17	0.83	0.64	1.81
24	2.05	1.73	1.59	1.40	1.45	2.06	1.48	0.91	1.13	1.59	2.08	0.93	1.02	0.99	0.96	1.80
25	1.99	1.73	1.77	1.33	1.56	1.90	1.62	1.29	0.93	1.73	1.97	1.02	0.89	1.04	1.76	1.33
26	2.24	1.28	2.09	1.51	1.47	2.02	2.07	1.23	1.15	1.72	1.50	1.19	0.95	0.86	1.64	0.54
27	2.15	2.22	2.22	1.62	1.56	2.13	1.67	1.42	0.95	1.33	1.45	0.89	0.89	0.93	1.76	0.62
28	1.73	1.33	1.79	1.49	1.28	1.77	2.06	1.11	1.12	1.34	1.88	1.17	1.16	0.81	0.95	1.35
29	1.95	1.51	1.47	1.51	1.66	1.86	1.53	1.25	0.84	0.81	1.48	0.85	0.82	0.99	0.59	1.25
30	2.12	2.22	1.61	1.52	1.21	2.00	1.45	1.03	0.94	1.15	1.22	1.86	0.96	0.94	1.44	0.89
31	1.54	1.57	1.79	1.64	1.51	1.97	2.03	1.19	0.98	0.90	1.71	1.49	0.93	0.92	0.69	1.41
32	1.59	1.71	2.22	1.58	1.54	1.57	1.82	1.09	1.16	1.17	1.84	1.42	0.79	0.80	1.17	1.69
33	1.66	1.48	1.81	1.33	1.67	1.91	1.88	1.02	0.92	1.01	1.66	1.63	0.97	0.80	1.32	1.89
34	1.74	1.44	2.53	2.27	1.23	1.79	1.71	1.58	1.00	0.85	1.55	1.79	0.88	1.30	1.83	1.62

Results in Table 2 clear that variance per basic unit area generally decreased with the increase in plot size. Variance per basic unit area in control 2002 and 2003 seasons decreased from 0.091 to 0.002 and from 0.107 to 0.031 for the smallest plot size (one basic unit) to the largest plot size(5 basic units) , respectively . Variance per basic unit in stress 2002 and 2003 seasons decreased from 0.122 to 0.015 and from 0.157 to 0.044 for one basic unit to 5 basic units, respectively .

On the other hand , Increasing plot size increased variance among plots that reached its maximum by increasing plot size from one basic unit to 34 basic
units for control 2003 and stress 2002 and 2003 seasons , and to 17 basic units for control 2002 season .

Data of standard deviation for each plot combination expressed as a percentage of the mean (C.V.%) for G.2 in control and stress treatments for 2002 and 2003 seasons ,respectively are presented in Table 3. The results showed that C.V.% values decreased as the plot size increased for the smallest basic unit area to the largest plot size.

The data of G.2 revealed that the average C.V. decreased from 16.639% to 2.572% and from 20.374% to 10.969% for control 2002 and 2003 seasons , respectively. Meanwhile it ranged from 27.070% to 9.313% and from 35.833% to 19.010% for stress 2002 and 2003 seasons , respectively.

According to the maximum curvature method, the coefficient of variability was used as an indictor to optimum plot size , and it is graphed on the Y axis in relation to various plot sizes on the X axis, (figs 1,2,3,and 4). The optimum plot size was considered to be the point on the curve, where the rate of change for Y estimate per increasement of X is greatest, so Called "The region of maximum Curvature".

Figs. (1,2,3 and 4) show the graphical relationship between plot size and the coefficient of variability, and the exponential functions expressed that relationship for G.2 control and stress treatments for 2002 and 2003 seasons. The general equation describing this relationship is:

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

Where A and B are constants, and X is the size of plot in basic units. The values of A and B were estimated and found to be 17.026 and 0.41204, 17.364 and 0.10214 for control G.2 treatment for 2002 and 2003 seasons , respectively. Meanwhile for stress treatment 2002 and 2003 seasons were 24.904 and 0.22719 , 34.623 and 0.19466 , respectively.

Thus the equations were defined as :

$C.V = 17.026\ X^{-0.41204}$ $\qquad$ $C.V = 17.364\ X^{-0.10214}$

$C.V = 24.904\ X^{-0.22719}$ $\qquad$ $C.V = 34.623\ X^{-0.19466}$

For G.2 experiments the point of Maximum curvature was 15.117m^2 and 5.486 m^2 for 2002 and 2003 control treatment, respectively. Therefore optimum plot size was 10.3 m^2 for the average of two seasons (the optimum plot size for control was 4 and 2 basic units for them , respectively therefore optimum plot size was 3 basic units) , Masood and Javed (2003) studied that the optimum plot sizes for maize trials where it was estimated to be 3.75 x 3.75 m (14.06m^2) with square shape for Agriculture Research Institute (ARI).

Table 2: Variance and coefficient of variability of different plot sizes and shapes for 5 combinations from 136 basic units of G.2 maize (control and stress irrigation treatments for 2002 and 2003 seasons) :

N	Plot size and shape			Total No . of plots	Control						stress					
	Size	Row	strips		Variance per basic units V_X		Variance among plots V(x)		C.V.		Variance per basic units V_X		Variance among plots V(x)		C.V.	
					2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
1	1	1	1	136	0.091	0.107	0.091	0.107	16.639	20.374	0.122	0.157	0.122	0.1574	27.070	35.833
2	2	1	2	68	0.043	0.045	0.171	0.179	11.398	13.182	0.052	0.106	0.208	0.4230	17.630	29.369
3	2	2	1	68	0.065	0.086	0.258	0.343	14.002	18.263	0.098	0.117	0.392	0.4683	24.232	30.900
4	4	2	2	34	0.024	0.036	0.378	0.582	8.473	11.890	0.039	0.083	0.634	1.3348	15.405	26.094
5	17	17	1	8	0.031	0.073	9.078	21.12	9.771	16.858	0.054	0.040	15.73	11.5478	18.054	18.052
6	34	17	2	4	0.002	0.031	2.516	35.76	2.572	10.969	0.015	0.044	16.74	51.2194	9.313	19.010

Table 3: Average variance per basic unit (v_x) , average yield for each plot size in uniformity trial maize G.2 (2002 and 2003 seasons) for control and stress irrigation treatments :

Plot size	Control								Stress							
	2002				2003				2002				2003			
	V_X	Y	C.V.Ob.	C.V.Est.	V_X	Y	C.V.Ob.	C.V.Est.	V_X	Y	C.V.Ob.	C.V.Est.	V_X	Y	C.V.Ob.	C.V.Est.
1	0.091	1.905	16.639	17.026	0.107	1.531	20.374	17.364	0.1224	1.315	27.070	24.904	0.1574	1.2	35.833	34.623
2	0.054	3.81	12.70	12.796	0.065	3.062	15.723	16.178	0.0749	2.63	20.931	21.275	0.1115	2.4	30.134	30.252
3	0.024	5.715	8.473	9.617	0.036	4.593	11.890	15.072	0.0396	3.945	15.405	18.175	0.0834	3.6	26.08	26.434
4	0.031	7.62	9.771	5.298	0.073	6.124	16.858	13.001	0.0544	5.26	18.054	13.083	0.0400	4.8	18.052	19.945
5	0.002	9.525	2.572	3.982	0.031	7.655	10.969	12.113	0.0145	6.575	9.313	11.177	0.0443	6	19.010	17.427

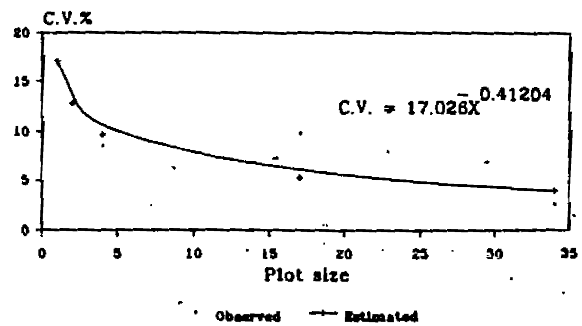

Fig.(1):Relationship between plot siz and coefficient of variability(CV)for Giza 2 (control irrigation 2002).

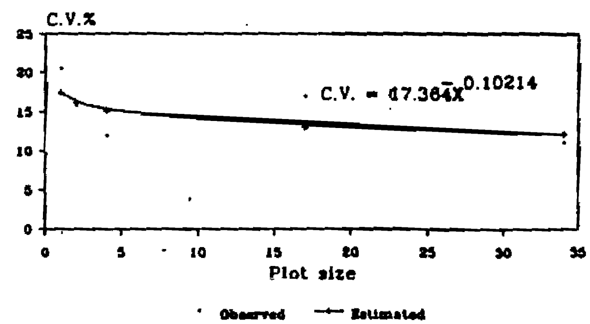

Fig.(2):Relationship between plot siz and coefficient of variability(CV)for Giza 2 (control irrigation 2003).

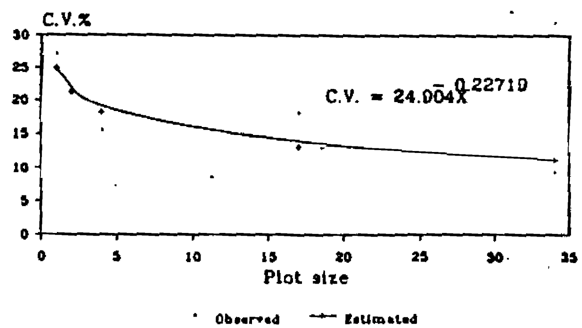

Fig.(3):Relationship between plot siz and coefficient of variability(CV)for Giza 2 (stress irrigation 2002).

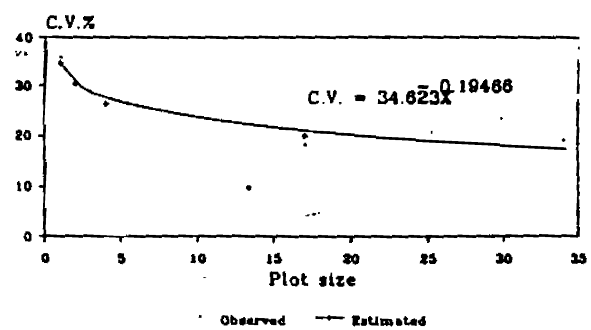

Fig.(4):Relationship between plot siz and coefficient of variability(CV)for Giza 2 (stress irrigation 2003).

Meanwhile optimum plot size for 2002 and 2003 stress treatment were 14.494 m^2 and 17.131 m^2, respectively (therefore optimum plot size was 15.8 m^2 for the average of two seasons). Therefore the optimum plot size for stress was 4 basic units for two seasons, Ashmawy(2004) reported that increasing plot size from one basic unit to 400 basic units reduced C.V from 20.187 to 4.925 respectively.

2- Comparable variance method :

The variance among plots V(x), was computed for each experiment for each type of plot combination then divided by the number of basic unit per plot (x) so that the variance would be comparable with that of the individual basic unit plot.

Comparable variance (v) of each plot size was compared with the basic unit as percent relative information (R.I.) the variance of basic units was assumed to contribute 100% relative information (R.I.) Table 4.

Table 4: Comparable variance (v) and relative information estimates (R.I) for various sizes in basic units for G.2 (2002 and 2003 seasons in control and stress irrigation treatments.

Plot size in basic unit	Control				Stress			
	2002		2003		2002		2003	
	V	R.I	V	R.I	V	R.I	V	R.I
1	0.091	100	0.107	100	0.122	100	0.157	100
2	0.086	105.81	0.089	120.22	0.104	117.31	0.212	74.42
2	0.129	70.54	0.172	62.21	0.196	62.24	0.234	67.21
3	0.126	72.22	0.194	55.15	0.211	57.82	0.445	35.37
4	2.27	4.01	5.28	2.27	3.93	3.10	2.89	5.45
5	0.503	18.09	7.15	1.49	3.35	3.64	10.24	1.45

As plot size increased , relative information decreased, as did variance of yield per unit area. For example, the values of comparable variance increased from 0.107 to 7.15 for control treatment 2003 season and for stress treatment 2003 season were from 0.157 to 10.24 as plot size increased from one to five basic units for them.

Since the comparable variance and relative information permit similar interpretation of the analysis of the data only the latter will be considered. The data in Table 4 indicate that the mean decrease in relative information on an individual unit difference, it is less noticeable as plot size increases more than 2 basic units for control and stress treatments for 2002 and 2003 seasons .

The data further suggested that the relative information changed only a relatively small amount after these points. Abnormal values of relative information may be due to the heterogeneity of soil, i.e., the large value of estimated (b), Nasr (1994) reported that variation is directly related to the position and size of the plot in the field depending mainly on soil fertility gradients . therefore , the magnitude of experimental error can be reduced by using optimum plot size and shape in experimental design .

The recommended plot size by using maximum curvature method with comparable variance method for Giza2 is ranged from 2 to 3 basic units

(8.4 to 12.6 m^2) for control irrigation treatment and ranged from 2 to 4 basic units (8.4 to 16.8 m^2) for stress irrigation treatment .

S.C.10 in control and stress irrigation treatments for 2002 and 2003 seasons :

1- Maximum Curvature method :

Data presented in Table 5 indicated that the total yield per basic unit ranged from 1.38 to 2.72kg with an average of 2.05kg for control 2002 season and from 1.44 to 2.38kg with an average of 1.91Kg. Meanwhile in stress 2002 and 2003 seasons the total yield per basic unit ranged from 0.56 to 2.72kg . With an average of 1.64kg and ranged from 0.48 to 2.18kg With an average of 1.33kg , respectively.

Table 6 Showed that variance per basic unit area in control 2002 and 2003 seasons decreased from 0.0508 to 0.0018 and from 0.0324 to 0.0007 for one basic unit to 5 basic units plot size , respectively and variance per basic unit area in stress 2002 and 2003 seasons decreased from 0.1732 to 0.0327 and from 0.1509 to 0.0008 for one basic unit to 5 basic units plot size , respectively . On the other hand variance among plots that reached its maximum by increasing plot size from one basic unit to 5 basic units for control 2002 and 2003 seasons and stress 2002 season , and to 4 basic units for stress 2003 season .

The coefficient of variability as shown in Table 7 ranged from 11.011% to 2.080% and from 9.555% to 1.397% for control treatment for 2002 and 2003 seasons , respectively. Meanwhile the coefficient of variability for stress treatment ranged from 28.79% to 12.51% and from 31.719% to 2.292 % for 2002 and 2003 seasons , respectively.

The relationship between the coefficient of variability and plot size was described by the equation : $C.V. = A X^{-B}$ where A and B for control treatment 2002 and 2003 seasons were found to be 11.464 and 0.47257, 10.057 and 0.55108 , respectively . and for stress 2002 and 2003 seasons 25.249 and 0.15990, 36.215 and 0.62121 , respectively .

Thus the equations was defined as illustrated by Figs (5,6,7 and 8) :

$C.V = 11.464\ X^{-0.47257}$ $\quad$ $C.V = 10.057\ X^{-0.55108}$

$C.V = 25.249\ X^{-0.15990}$ $\quad$ $C.V = 36.213\ X^{-0.62121}$

For control and stress 2002 and 2003 seasons , respectively.

For S.C.10 experiments the point of maximum curvature was 12.195 m^2 and 11.902 m^2 for 2002 and 2003 for control treatment respectively (the optimum plot size for control treatment was 12.05 m^2 for average of two seasons) the optimum plot size was 3 basic units for the two control treatments for 2002 and 2003 seasons .

Meanwhile optimum plot size for S.C.10 experiments, the point of maximum curvature was 11.313m^2 and 27.312m^2 For 2002 and 2003 seasons, respectively for stress treatment (optimum plot size for average of two seasons was 19.31 m^2) therefore the optimum plot size was 3 and 7 basic units(average of the two seasons is 5 basic units) for stress treatment , respectively , (Salem and Salama(2001) reported that according to modified Maximum curvature procedure the optimum plot size for wheat yield trial were 21.28 and 18.92 m^2 basic units in the first and second seasons , respectively.

Table (5):Maize yield in (kg) for each basic unit one row in four strips in uniformity trials of 2002 and 2003 for S.C10 :

Strip / Row	Control								Stress							
	2002				2003				2002				2003			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	2.48	2.22	1.88	2.13	2.30	2.01	2.14	1.79	1.26	2.48	1.32	1.22	1.40	0.84	1.59	0.48
2	2.24	2.16	1.94	2.37	1.80	1.48	1.82	1.99	1.34	2.31	1.20	1.02	1.15	0.83	1.06	0.79
3	2.00	2.20	2.14	1.79	1.67	1.91	1.84	1.75	0.89	2.00	1.06	0.89	0.72	0.89	1.04	1.69
4	2.72	2.04	2.18	2.07	1.62	2.08	1.73	1.84	0.97	2.72	0.89	1.53	1.13	0.80	1.24	1.89
5	2.03	2.08	2.18	1.99	1.55	2.06	2.15	1.95	1.19	2.03	1.24	1.71	1.05	1.72	1.53	1.62
6	2.15	2.13	2.00	2.22	1.69	1.89	2.08	1.79	1.48	2.15	1.09	1.22	1.09	2.02	1.34	0.57
7	2.38	2.22	2.08	2.27	1.92	2.01	1.98	2.01	1.39	2.38	1.43	1.04	0.94	1.94	0.91	0.54
8	2.24	1.89	1.92	1.83	1.44	1.48	1.89	1.97	1.24	2.24	1.48	0.97	0.73	1.82	1.29	1.29
9	2.27	1.99	1.99	2.04	1.75	1.91	1.85	1.66	1.01	2.24	1.31	1.86	1.16	1.49	1.01	1.20
10	2.31	2.08	2.12	2.05	1.82	2.08	1.99	2.06	1.39	2.31	0.92	1.39	1.13	1.78	1.25	1.73
11	2.37	1.79	1.73	1.84	2.12	1.89	1.67	1.73	1.44	2.37	1.48	1.41	0.95	1.36	0.91	1.80
12	1.84	1.59	1.99	2.04	1.99	1.92	1.81	1.81	1.28	1.84	1.26	1.70	0.99	1.43	1.29	1.33
13	2.22	1.61	2.00	2.09	1.97	1.72	1.96	1.81	1.06	2.22	1.35	1.84	0.91	0.97	1.34	0.54
14	1.91	2.23	2.02	1.99	1.60	1.91	2.05	1.88	1.11	1.91	1.39	1.83	1.39	1.12	1.49	0.65
15	1.75	2.48	2.35	2.07	1.88	1.95	2.01	2.04	1.70	1.74	1.38	1.64	0.84	1.61	1.18	1.37
16	2.06	2.03	2.19	2.15	1.72	1.84	1.87	2.05	1.04	2.06	1.14	1.45	0.67	2.00	1.15	1.31
17	1.56	2.31	2.09	1.61	1.70	2.02	1.89	1.53	1.31	1.56	1.18	1.49	2.18	2.00	1.03	1.47
18	1.86	2.19	2.34	1.57	2.16	1.69	1.87	1.73	1.48	0.73	1.02	1.69	0.74	1.71	1.63	0.79
19	1.67	2.33	1.67	1.65	1.78	1.47	1.75	1.85	1.34	1.20	1.01	1.56	0.96	1.58	1.06	1.69
20	2.16	2.30	2.01	2.13	1.83	1.98	1.79	1.95	1.29	1.16	1.03	1.57	1.12	1.62	1.05	1.89
21	2.22	2.17	1.91	1.99	1.94	2.14	1.76	2.03	1.32	1.25	0.65	1.64	1.19	1.42	1.14	1.62
22	2.29	2.23	1.78	1.98	1.94	2.04	1.87	1.91	1.07	1.64	1.63	1.45	0.85	1.56	1.22	0.57
23	1.87	1.93	2.09	1.96	2.01	1.96	1.95	1.76	1.31	1.11	1.59	1.68	0.72	0.97	1.06	0.54
24	2.15	2.06	1.91	1.76	1.49	1.84	2.23	1.79	1.27	1.17	1.25	1.71	1.36	1.01	1.05	1.29
25	1.38	1.84	2.52	1.83	1.79	1.47	2.12	1.99	1.34	1.31	1.21	1.52	1.32	1.25	1.14	1.20
26	1.86	1.84	1.83	2.26	1.74	1.98	1.84	1.75	0.63	1.55	1.28	1.67	0.81	1.83	1.65	1.73
27	1.69	1.86	2.14	1.86	2.24	2.13	1.91	1.84	1.60	1.49	1.09	1.72	0.85	1.91	1.27	1.80
28	2.37	2.07	1.98	1.94	1.80	1.98	1.82	1.95	1.75	2.35	1.09	1.33	1.05	2.03	1.02	1.33
29	1.84	2.00	2.04	1.76	1.67	2.19	2.04	1.79	1.32	2.29	1.34	1.34	1.12	1.58	1.32	0.54
30	2.03	2.27	2.12	2.17	1.87	1.68	1.75	2.01	1.41	2.35	1.32	0.85	0.89	1.64	1.09	0.65
31	1.75	2.08	2.22	2.03	1.95	1.56	1.66	2.14	1.32	1.97	1.24	1.11	1.02	1.49	0.91	1.37
32	1.69	2.05	2.14	2.07	1.81	1.87	1.98	2.02	1.39	2.08	1.45	0.97	0.98	1.37	1.29	0.79
33	2.28	2.04	2.05	2.00	2.06	2.09	2.04	1.71	1.04	1.91	1.22	0.98	1.05	0.69	1.34	0.89
34	2.55	2.39	2.28	2.16	2.38	1.94	2.04	1.92	1.41	1.64	1.30	0.56	0.99	0.72	1.49	1.73

Table 6: Variance and coefficient of variability of different plot sizes and shapes for 5 combinations from 136 basic units of S.C.10 maize (control and stress irrigation treatments for 2002 and 2003 seasons.

N	Plot size and shape			Total No . of plots	Control						Stress					
	Size	row	strips		Variance per basic units V_x		Variance among plots V(x)		C.V.		Variance per basic units V_x		Variance among plots V(x)		C.V.	
					2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
1	1	1	1	136	0.0508	0.0324	0.0508	0.0324	11.011	9.555	0.1732	0.1509	0.1732	0.1509	28.791	31.719
2	2	1	2	68	0.0266	0.0175	0.1063	0.0700	7.966	7.022	0.0670	0.0605	0.2681	0.2420	17.910	20.080
3	2	2	1	68	0.0310	0.0165	0.1240	0.0658	8.602	6.812	0.1465	0.1070	0.5851	0.4280	26.480	26.707
4	4	2	2	34	0.0165	0.0088	0.2647	0.1413	6.284	4.990	0.0558	0.0377	0.8921	0.6036	16.335	15.857
5	17	17	1	8	0.0040	0.0016	1.1448	0.4600	3.075	2.118	0.0970	0.0236	28.0404	6.8156	21.548	12.538
6	34	17	2	4	0.0018	0.0007	2.0951	0.8001	2.080	1.397	0.0327	0.0008	37.8223	0.9110	12.513	2.292

Table 7: average variance per basic unit (v_x) , average yield for each plot size in uniformity trial maize S.C.10 (2002 and 2003 seasons) for control and stress irrigation treatments.

Plot size	Control								Stress							
	2002				2003				2002				2003			
	V_x	Y	C.V.Ob.	C.V.Est.	V_x	Y	C.V.Ob.	C.V.Est.	V_x	Y	C.V.Ob.	C.V.Est.	V_x	Y	C.V.Ob.	C.V.Est.
1	0.051	2.053	11.011	11.465	0.032	1.925	9.555	10.057	0.173	1.64	28.79	25.249	0.15	1.221	31.719	36.214
2	0.029	4.106	8.284	8.262	0.017	3.849	6.917	6.8641	0.105	3.28	22.19	22.599	0.08	2.441	23.394	23.543
3	0.017	6.159	6.284	5.954	0.009	5.774	4.990	4.6848	0.056	4.92	16.34	20.229	0.038	3.662	15.857	15.306
4	0.004	8.218	3.075	3.005	0.002	7.698	2.118	2.1106	0.097	6.55	21.55	16.050	0.038	4.882	12.538	6.230
5	0.002	10.27	2.080	2.166	0.001	9.623	1.397	1.4405	0.033	8.20	12.51	14.366	0.001	6.103	2.292	4.050

2- Comparable variance method:

Comparable variance (V) of each plot size was compared with the basic unit. As plot size increased, relative information decreased as did variance per unit area. For example, Table 8, showed that the values of comparable variance increased from 0.1732 to 7.56 for stress treatment 2002 season as plot size increased from one to five basic units for them so it is less noticeable as plot size increase more than 3 basic units for control 2002 and 2003 control seasons , 2 basic units for stress 2002 and 2003 seasons .

The recommended optimum plot size for S.C.10 is 3 basic units (12.6 m^2) for control irrigation treatment , ranged from 2 to 5 basic units (8.4 to 21 m^2) for stress irrigation treatment and that according to maximum curvature method with comparable variance method .

Table 8: Comparable variance (v) and relative information estimates (R.I) for various sizes in basic units for S.C.10 (2002 and 2003 seasons in control and stress irrigation treatments

Plot size in basic unit	Control				Stress			
	2002		2003		2002		2003	
	V	R.I	V	R.I	V	R.I	V	R.I
1	0.051	100	0.032	100	0.173	100	0.151	100
2	0.053	95.94	0.035	92.57	0.134	129.16	0.121	124.71
2	0.062	81.94	0.033	98.48	0.293	59.19	0.214	70.51
3	0.088	57.59	0.047	68.79	0.297	58.24	0.201	75
4	0.286	17.15	0.115	28.17	7.01	2.47	1.70	8.88
5	0.419	12.12	0.160	20.25	7.56	2.29	0.182	82.82

Optimum plot shape :

Coefficient of variability (C.V.) are presented in Tables (9 and10) for different sizes of G.2 and S.C.10 in 2002 and 2003 seasons for control and stress irrigation treatments , respectively indicating that C.V. decreased as plot size increased and that increasing the number of strips for a fixed plot size reduced the C.V. more effectively than increasing the numbers of rows .

For example, in the first season 2002 Table (9) for G.2 control irrigation treatment a plot size of one basic unit resulted in a C.V. of 11.398 % the plot consisted of 1 row in 2 strips and 14.002 % when the plot consisted of 2 row in 1 strip.

In the second season 2003 Table (9) for G.2 control irrigation treatment a plot size of basic unit resulted in a C.V of 13.182 % when the plot consisted of a row in 2 strips and 18.263 % when the plot consisted of 2 rows in 1 strip.

In stress irrigation treatment for G.2 a plot size of basic unit resulted in a C.V. of 17.630 % and 24.232 % when the plot consisted of 1 row in 2 strips and 2 rows in 1 strip , respectively for 2002 season , in 2003 season for stress irrigation treatment a plot size of basic unit resulted in a C.V. of 29.369 % and 30.900 % for 1 row in 2 strips and 2 rows in 1 strip , respectively . Nearly similar trend in Table (10) could be observed in S.C 10 for the two irrigation treatments for 2002 and 2003 seasons . According to Table (9 and 10) Variance per basic unit decreased when the long direction of plot was along the rows .

Table 9 : Coefficient of variability for different plot sizes of G.2 for 2002 and 2003 for control and stress treatments , respectively.

Number of rows in the plot	Number of strips in the plot			
	Control			
	2002		2003	
	1	2	1	2
1	16.639	11.398	20.374	13.187
2	14.002	8.473	18.263	11.890
17	9.771	2.572	16.858	10.969
	Stress			
	2002		2003	
	1	2	1	2
1	27.070	17.630	35.833	29.369
2	24.232	15.405	30.900	26.094
17	18.054	18.054	18.052	19.010

Table10: Coefficient of variability for different plot sizes of S.C.10 for 2002 and 2003 for control and stress treatments , respectively.

Number of rows in the plot	Number of strips in the plot			
	Control			
	2002		2003	
	1	2	1	2
1	11.011	7.966	9.555	7.022
2	8.602	6.284	6.812	4.284
17	3.075	2.080	2.118	1.397
	Stress			
	2002		2003	
	1	2	1	2
1	28.791	17.910	31.719	20.080
2	26.480	16.335	26.707	15.857
17	21.548	12.513	12.538	2.292

Number of replications :

The theoretical number of replications for various plot sizes are presented in Tables (11 and 12) , It was clearly noticed that the theoretical number of replications decreased as the plot size increased. These results were found for G.2 and S.C.10 in the two seasons for control irrigation treatment meanwhile stress irrigation treatment for G.2 and S.C.10 fluctuate from plot one size to the other therefore under stress treatment using large number of replications helps to withstand the decrease in yield from stress conditions .

Table 11: Theoretical number of replicates for different plot sizes for G.2 in the two irrigation treatments (control+ stress) for 2002 and 2003 seasons

Plot size in basic unit	Number of replicates			
	control		stress	
	2002	2003	2002	2003
1	11	17	29	51
2	5	7	12	35
2	8	13	23	38
3	3	6	9	27
4	4	11	13	13
5	1	5	3	14

Table 12: Theoretical number of replicates for different plot sizes for S.C.10 in the two irrigation treatments (control + stress) for 2002 and 2003 seasons :

Plot size in basic unit	Number of replicates			
	Control		stress	
	2002	2003	2002	2003
1	5	4	33	40
2	3	2	13	16
2	3	2	28	29
3	2	1	11	10
4	1	1	19	6
5	1	1	6	1

The relationship between number of replications , plot size, and standard error are illustrated by results presented in Tables 13 and 14 and Figs. (9,10 ,11 and 12) for Giza 2 and Figs. (13,14,15 and 16) for S.C.10 therefore results showed that standard error decreased as the number of replications and plot size increased, but the rate of decrease was more obvious due to increase in number of replications than increasing plot size. This was clear for G.2 and S.C.10 in control irrigation treatment seasons .

The relationship between standard error, and number of replications for different plot sizes showed that the rate of decrease in standard error reached its maximum up to 4 - 7 replicates for G.2 for control and stress treatments meanwhile for S.C.10 it reached its maximum up to 5 – 8 replicates for the two irrigation treatments. EL- Rassas 1982, found that in corn trials the optimum number of replicates were (6 – 8) replicates.

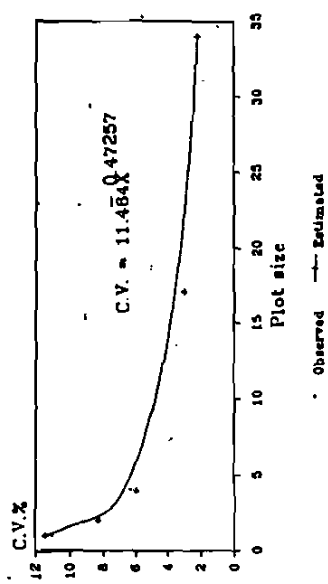

Fig.(5):Relationship between plot siz and coefficient of variability(CV)for S.C.10 (control irrigation 2002).

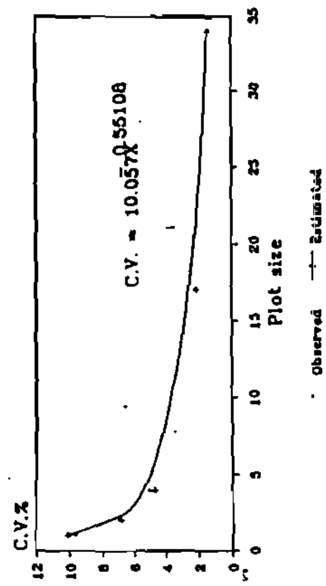

Fig.(6):Relationship between plot siz and coefficient of variability(CV)for S.C.10 (control irrigation 2003).

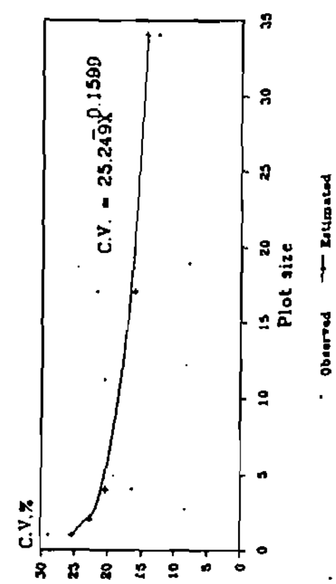

Fig.(7):Relationship between plot siz and coefficient of variability(CV)for S.C.10 (stress irrigation 2002).

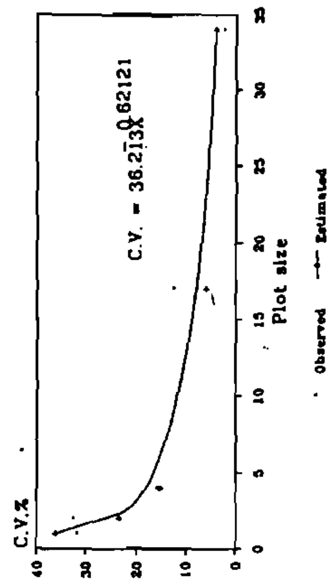

Fig.(8):Relationship between plot siz and coefficient of variability(CV)for S.C.10 (stress irrigation 2003).

Table 13: Estimates of the standard error for different plot sizes and number of replications for G.2 for the two irrigations treatments (control and stress) for 2002 and 2003 seasons.

Plot size in basic unit	Number of replications																	
	2	3	4	5	6	7	8	9	10	2	3	4	5	6	7	8	9	10
	Control 2002									Control 2003								
1	0.064	0.053	0.046	0.041	0.037	0.034	0.032	0.030	0.028	0.076	0.062	0.054	0.048	0.043	0.040	0.038	0.036	0.034
2	0.038	0.031	0.027	0.024	0.022	0.020	0.019	0.018	0.017	0.047	0.038	0.033	0.029	0.027	0.025	0.023	0.022	0.021
3	0.016	0.014	0.012	0.010	0.0097	0.0090	0.0083	0.008	0.007	0.025	0.021	0.018	0.016	0.015	0.014	0.013	0.012	0.011
4	0.022	0.018	0.015	0.014	0.013	0.012	0.0109	0.0103	0.009	0.052	0.042	0.037	0.033	0.029	0.028	0.026	0.024	0.023
5	0.002	0.0017	0.0015	0.0013	0.0012	0.0011	0.001	0.001	0.0009	0.022	0.018	0.016	0.014	0.013	0.012	0.0109	0.0103	0.009
	2	3	4	5	6	7	8	9	10	2	3	4	5	6	7	8	9	10
	Stress 2002									Stress 2003								
1	0.086	0.070	0.061	0.055	0.049	0.046	0.043	0.041	0.038	0.111	0.091	0.079	0.070	0.064	0.059	0.056	0.052	0.049
2	0.053	0.043	0.038	0.034	0.031	0.028	0.027	0.025	0.024	0.079	0.065	0.056	0.050	0.046	0.042	0.039	0.037	0.035
3	0.028	0.023	0.019	0.017	0.016	0.015	0.014	0.013	0.012	0.059	0.048	0.042	0.037	0.034	0.031	0.029	0.028	0.026
4	0.038	0.031	0.027	0.024	0.022	0.020	0.019	0.018	0.017	0.028	0.023	0.02	0.018	0.016	0.015	0.014	0.013	0.012
5	0.011	0.008	0.007	0.0067	0.0061	0.0056	0.0053	0.005	0.004	0.031	0.025	0.022	0.019	0.018	0.017	0.016	0.015	0.014

Table 14: Estimates of the standard error for different plot sizes and number of replications for S.C.10 for the two irrigations treatments (control and stress) for 2002 and 2003 seasons.

Plot size in basic unit	Number of replications																	
	2	3	4	5	6	7	8	9	10	2	3	4	5	6	7	8	9	10
	Control 2002									Control 2003								
1	0.036	0.029	0.025	0.023	0.021	0.019	0.018	0.017	0.016	0.023	0.018	0.016	0.014	0.013	0.012	0.011	0.010	0.0102
2	0.020	0.017	0.014	0.013	0.012	0.011	0.010	0.0096	0.0091	0.012	0.009	0.008	0.007	0.0069	0.0064	0.0060	0.0056	0.0053
3	0.012	0.009	0.008	0.007	0.0065	0.0062	0.0058	0.0055	0.0052	0.006	0.005	0.004	0.0039	0.0035	0.0033	0.0031	0.0029	0.0027
4	0.0028	0.0023	0.002	0.0017	0.0016	0.0015	0.0014	0.0013	0.0013	0.001	0.0009	0.0008	0.0007	0.00065	0.0006	0.00056	0.00053	0.0005
5	0.0012	0.0010	0.0009	0.0008	0.0007	0.00068	0.00063	0.0006	0.0005	0.00049	0.0004	0.00035	0.00031	0.00029	0.00026	0.00024	0.00023	0.00022
	2	3	4	5	6	7	8	9	10	2	3	4	5	6	7	8	9	10
	Stress 2002									Stress 2003								
1	0.122	0.099	0.086	0.077	0.070	0.065	0.061	0.058	0.054	0.107	0.087	0.075	0.067	0.062	0.057	0.053	0.050	0.048
2	0.076	0.063	0.054	0.048	0.044	0.040	0.038	0.035	0.033	0.059	0.048	0.042	0.038	0.034	0.032	0.029	0.028	0.026
3	0.039	0.032	0.028	0.025	0.023	0.021	0.0197	0.0185	0.0176	0.026	0.022	0.019	0.017	0.015	0.014	0.013	0.0125	0.012
4	0.069	0.056	0.049	0.043	0.039	0.037	0.034	0.032	0.031	0.016	0.014	0.012	0.011	0.0096	0.0089	0.0083	0.0078	0.0074
5	0.023	0.019	0.016	0.015	0.013	0.0123	0.012	0.0109	0.0103	0.0005	0.00046	0.0004	0.00035	0.00032	0.0003	0.00028	0.00026	0.000245

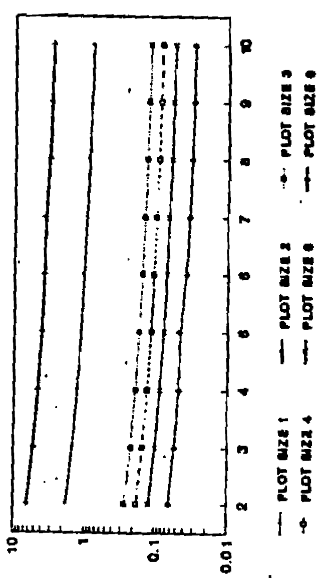

Fig.(9):The relationship between standard error for different plot sizes and various number of replications.

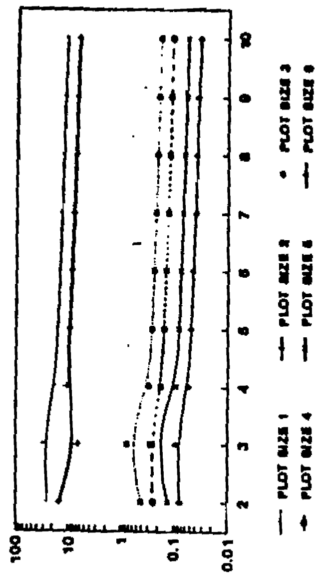

Fig.(10):The relationship between standard error for different plot sizes and various number of replications.

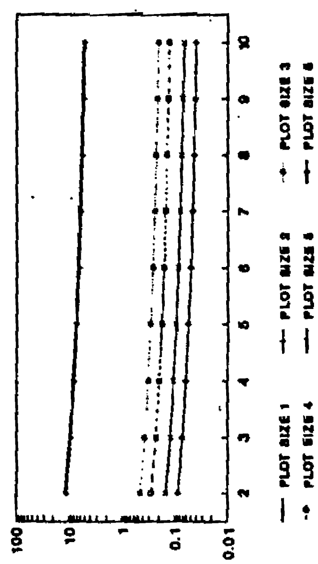

Fig.(11):The relationship between standard error for different plot sizes and various number of replications.

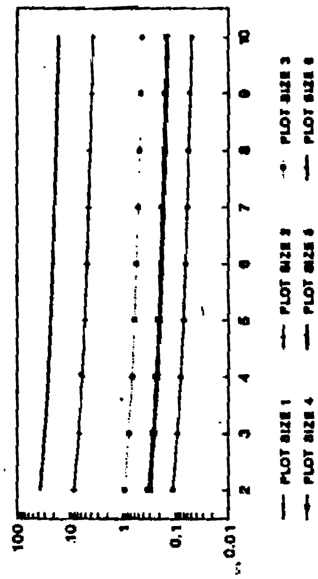

Fig.(12):The relationship between standard error for different plot sizes and various number of replications.

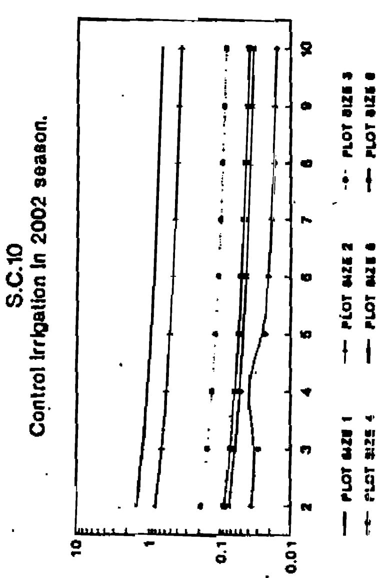

Fig.(13):The relationship between standard error for different plot sizes and various number of replications.

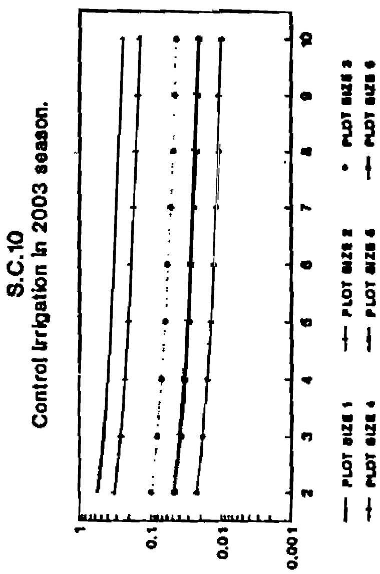

Fig.(14):The relationship between standard error for different plot sizes and various number of replications.

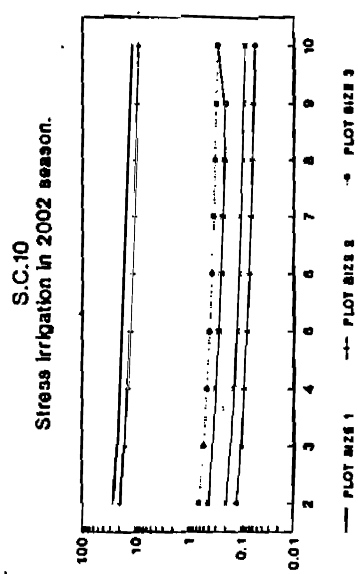

Fig.(15):The relationship between standard error for different plot sizes and various number of replications.

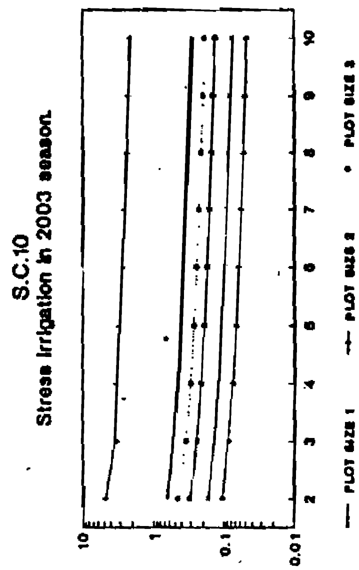

Fig.(16):The relationship between standard error for different plot sizes and various number of replications.

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تقنيات الوحدات التجريبية في تجارب تقييم تراكيب الذرة الشامية تحت ظروف الجفاف

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**** مركز البحوث الزراعيه – المعمل المركزى للتصميم و التحليل الاحصائى**

أجريت هذه الدراسة لتقدير بعض المعالم الإحصائية لتجربة تضم تركيبين وراثيين جيزه٢ و هجين فردى١٠ مثل تقدير انسب شكل ومساحة للقطعة التجريبية وانسب عدد للمكررات وجد أن انسب مساحة للقطعة التجريبية ٣ وحدة أساسية (١٢,٦م٢) و ٤ وحدة أساسية (١٦,٨م٢) وذلك لكل من المعاملة التقليدية والتقسية على التوالي وذلك باستخدام طريقة أقصى انحناء بينما باستخدام طريقة التباين المقارن وجد أن انسب مساحة ٢ وحدة أساسية (٨,٤ م٢) لكلا من المعاملتين ووجد أن انسب مساحة لهجين فردى١٠(٣ وحدة أساسية (١٢,٦م٢) و ٥ وحدة أساسية (٢١ م٢) وذلك لمعاملتي المقارنة والتقسية على التوالي وذلك باستخدام طريقة أقصى انحناء بينما استخدام طريقة التباين المقارن وجد أن انسب مساحة تراوحت ما بين ٣ وحدة أساسية (١٢,٦ م٢) وذلك لمعاملة التقليدية و ٢ وحدة أساسية لمعاملة التقسية (٨,٤ م٢) وبالتالي انسب مساحة لكلا من الطريقتين معا (طريقة أقصى انحناء + طريقة التباين المقارن)لجيزة٢ تراوحت ما بين ٨,٤ إلي ١٢.٦ م٢ للمعاملة التقليدية و ٨.٤ إلي ١٦.٨ م٢ لمعاملة التقسية بينما كانت انسب مساحة لمعاملة المقارنة لهجين فردى١٠ (١٢,٦م٢) وتراوحت ما بين ٨.٤ إلي ٢١ م٢ لمعاملة التقسية و كان عدد المكررات الأمثل هو ٤ – ٧ و ٥ – ٨ مكررة لكل من جيزه٢ و هجين فردى ١٠ على التوالي وذلك لكلا من المعاملتين .