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FIELD PLOT TECHNIQUE STUDIES FOR LATIN SQUARE DESIGEN IN ONION EXPERIMENTS

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ABSTRACT

Two uniformity experiments were conducted at the Agricultural Research Station of Sids, Beiny Suef Governorate to study the interrelations among different sizes of squares, samples, and plots during 2004/2005 and 2005/2006 seasons.

The trails were transplanted by onion variety Giza 20 and the actual area of each trial was divided into 12 strips. Each strip consisted of 144 ridges considering the ridge as basic unit with total ridges of 1728 and basic units (rows) were separately harvested. Study of interrelations among sizes of squares, samples and plots based on high relative efficiency (high precision), critical limit of coefficient of variation (C.V ≤ 15%) and critical limit of significance (≤ 5%) between plot means (treatment means) in the two seasons . The relative efficiency (RE) for Latin square design was estimated as related to completely randomized design (CRD) supposing homogeneity of experimental conditions.

Results cleared that changing of plot size led to changing square size, changing RE, C.V and consequently critical limit of significance between plot means in the two seasons. The optimum combinations from sizes of squares and plots were 10x10 and 11x11, for 1.8 and 3.6 m^2 plot sizes and 9x9 size of square, for 5.4, 7.2 and 9 m^2 plot sizes and 8x8 size of square for plot size 10.8 m^2 and 7x7 size of square for 12.6 and 14.4 m^2 plot size and 6x6 size of square for 16.2, 18 and 19.8 m^2 plot sizes and 5x5 size of square for 21.6 m^2 plot size. Results also recorded the highest gain of precision of Latin square design being 26, 27.61, 33.35, 49.64, 45.64, 93.97, 50.58, 45.24, 32.03,24.98, 14.87, and 11.59% in first season and 22.48, 30.20, 26, 33, 29, 11, 25, 49, 26, 42,19 and 27% in the second season with sizes of plots of 1.8, 3.6, 4.5, 7.2, 9, 10.8, 12.6, 14.4, 16.2, 18, 19.8 and 21.6 m^2, respectively. Critical limit of coefficient of variation (C.V ≤ 15%) ranged from 15 to 6.34 % in the first season and from 15 to 10.16 % in the second season. Critical limit of significance between plot means (≤ 5%) ranged from 0.288 to 0.075 in the first season and from 0.342 to 0.064 in the second season for the optimum combinations.

The previous results give researcher a chance to determine his optimum combinations from sizes of squares and plots depending upon variability of his variables, the nature of his treatments and their costs. Also researcher can depend upon maximum gain of precision (RE), critical limit of coefficient of variation (C.V) and critical limit of significance between plot means for indicating homogeneity of the experimental field.

INTRODUCTION

Accuracy of experimental results is affected by soil heterogeneity as a major factor. This effect can be minimized by the choice of a proper design and the use of optimum block and plot sizes, number of replications and sample size. Uniform plots and blocks are very important to detect the true differences between treatment means because size of block, number of plots per block and number of samples per plot depend upon degree of soil variability.

Several factors have to be taken into consideration to study the efficient of Latin square design as size of square (rows x columns), size of plot per treatment and size of sample. These factors are very important to detect the true variability between treatment means and it extremely difficult to take only a single factor under consideration in the study.

Chica and Rodriquez (1967) on onion trials found that 22.32 m^2 was optimum plot size. Abou EL-Fittouh (1977) concluded that the Latin square design, was efficient than the completely randomized design, or the randomized complete block design with rows or columns as blocks. El-Kalla *et. al.* (1981) on onion trials they found that the optimum plot size was 7.2 m^2. Abd EL-Halim *and Saad* (1989) found that the Latin square design expressed high relative efficiency over randomized complete blocks (142.91%). Surin (1992) studied the sensitivity of statistical tests to detect the differences between treatment means. He found that, when the sample size ranged from 20 to 24 plants, efficiency was higher than that of simple random sampling. EL-Taweel (1999) on maize showed that precision of Latin square design with 5x5, 6x6 and 7x7 treatments with plot size ranged from 4.2m^2 to 25 m^2 recorded 22, 24 and 47% in the first season and 26, 75 and 79% in the second season. Also he found that averages of coefficient of variation were approximately 13% and 12% and these values were considerably lower than those commonly obtained in maize yield trials indicating that the soil field should be as homogeneous as possible to obtain highly accurate results. Barakat (2002) on onion fertilization trials showed that the optimum plot size was ranged from 40 to 90 m^2. EL-Taweel (2004) in his study on wheat for number of plots (k), blocks (b), sample (s) as well as their sizes in randomized complete blocks design, found that increasing sample size followed by increasing number of plots per block with decreasing of sample and experimental errors for all optimum combinations. Ragab *et. al.* (2006) on onion reported that optimum plot size were 14.968 and 9.168m^2 in the first and second season, respectively.

To give the researchers a chance to choose optimum combinations from size of squares that suits size of plot per treatments with maximum gain of precision and low costs, the current study aimed to investigate interrelations between size of squares and size of plot for Latin square design in onion *(Allium cepa L.)* experiments.

MATERIALS AND METHODS

Uniformity trails are outlined by planting the experimental site with a single crop variety and applying all cultural and management practices as uniformly as possible. Sources of variation are kept constant except that due to soil heterogeneity.

The aim of the study was to investigate the interrelations among different sizes of squares (different number of rows x different number of columns), different samples {(different plot yields)/(different No. of rows/plots)} as row averages and different plot sizes under uniform conditions. Hence, two uniformity experiments were conducted at the Agricultural Research Station of Sids, Beiny Suef Governorate and were transplanted using onion variety Giza 20 with 10 cm. apart on both sides of each ridge on January 10th and 19th, during 2004/2005 and 2005/2006 seasons, respectively. The actual area of each trial (36 X 86.4 m = 3110.4 m^2 = 0.741 feddan) was divided into 12 strips. Each strip consisted of 144 ridges with 3 m long and 60 cm apart equal to 1.8 m^2 considering the ridge as basic unit with total ridges equal to 1728. Basic units (rows) were separately harvested on June 10th and 19th for the both seasons after discarding two plants from each end to eliminate the border effect. All recommended practices were done as usual in onion fields. Data were assigned in Latin square design with different combinations of size of squares, plots and different number of trails as shown in Table 1.

Table 1: Sizes of squares, plots and number of experiments analyzed in 2004/2005 and 2005/2006 seasons.

Size of squares (rows x columns)	No. of rows/ plot	Plot size (area/m^2)	No. of analyzed experiments
3x3, 4x4, 5x5, 6x6, 7x7, 8x 8, 9x9, 10x10, 11x11, 12x12	1	0.6x 3=1.8 0m^2	192, 108, 69, 48, 35, 27, 18, 17, 14, 12
" " " " " " " " " "	2	1.2x 3=3.6 0m^2	96, 54, 34, 24, 17, 13, 9, 8, 7, 6
" " " " " " " " " "	3	1.8x 3=5.4 0m^2	64, 36, 23, 16, 11, 9, 6, 4, 4,3
" " " " " " " " " "	4	2.4x 3=7.2 0m^2	48, 27, 17, 12, 8, 6, 4, 4, 3,3
" " " " " " " " " "	5	3x 3 =9.0 0m^2	38, 21, 13, 9, 7, 5, 3, 3, 2, 2
" " " " " " " " " "	6	3.6x 3=10.8 m^2	32, 18, 11, 8, 6, 4, 3, 2, 2, 2
" " " " " " " " " "	7	4.2x 3=12.6 m^2	27, 15, 9, 6, 5, 3, 2, 2, 2, 1
" " " " " " " " " "	8	4.8x 3=14.4 m^2	24, 13, 8, 6, 4, 3, 2, 2, 1, 1
" " " " " " " " " "	9	5.4x 3=16.2 m^2	21, 12, 7, 5, 3, 3, 2, 1, 1, 1
" " " " " " " " " "	10	6x 3 =18.0 m^2	19, 10, 6, 4, 3, 2, 1, 1, 1, 1
" " " " " " " " " "	11	6.6x 3=19.8 m^2	17, 9, 6, 4, 3, 2, 1, 1, 1, 1
" " " " " " " " " "	12	7.2x 3=21.6 m^2	16, 9, 5, 4, 2, 2, 1, 1, 1, 1

Statistical analysis:

The sizes of squares were obtained by using different numbers of rows x numbers of columns from basic units of each strip. Number of squares (analyzed experiments) was calculated as follows:

Number of squares = total number of basic units for all experiment / number of basic units per plot / size of square

Where:

1- Number of basic units per plot 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 rows.

2- Sizes of squares were 3x3, 4x4, 5x5, 6x6, 7x7, 8x 8, 9x9, 10x10, 11x11 and 12x12.

The size of plot was obtained by using a row length x row width x number of rows for each plot. Interrelations among sizes of squares, samples and plots were studied using three parameters namely: relative efficiency (high precision), critical limit of coefficient of variation (C.V ≤ 15%) and critical limit of significance (≤ 5%) between plot means (treatment means). The relative efficiency (RE) of Latin square design was estimated as related to completely randomized design (CRD) supposing homogeneity of experimental conditions, as follows:

$$RE\ (LS\ /\ RCBD) = \frac{Mse_1\,(n_1 + 1)(n_3 + 3)}{Mse_3\,(n_3 + 1)(n_1 + 3)} \times 100$$

Where:

LS	=Latin square design.
Mse_1	=mean square error for CRD.
Mse_3	=mean square error for LS.
n_1 and n_3	=degrees of freedom for CRD and Latin square designs, respectively.

The statistical analysis of variance for Latin square design was done as outlined by Steel and Torrie (1980) as shown in Table 2.

Table 2: Sources of variation, for Latin square design with expected mean squares.

Source of variance	Degrees of freedom	Expected mean square
Rows	r-1	-
Columns	c-1	-
Plots (treatments)	p-1	$\sigma^2_e + cr\,(\sum t_i^2)/(p-1)$
Experimental error	[(r-1)(c-1)] – (p-1)	σ^2_e

Where:

r = number of rows

c = number of columns

p = number of plots (treatments)

ti = treatment effect

σ^2_e = experimental error

RESULTS AND DISCUSSION

Different combinations of sizes of squares, samples and plots, relative efficiency, coefficients of variation (C.V) and probability of significance between plot means (treatment means) are presented in Table 3. Bold face line refers to the optimum combinations selected from these sizes that had high relative efficiency (high gain of precision), critical limit of coefficient of variation (C.V ≤ 15%) and critical limit of significance (≤ 5%) between plot means in the two seasons.

Table 3 clears the gain of precision of Latin square design over the completely randomized design being 26, 27.61, 33.35, 49.64, 45.64, 93.97, 50.58, 45.24, 32.03,24.98, 14.87, and 11.59% in first season and 22.48, 30.20, 26, 33, 29, 11, 25, 49, 26, 42,19 and 27% in the second season. This gain was recorded for sizes of plots of 1.8, 3.6, 4.5, 7.2, 9, 10.8, 12.6, 14.4, 16.2, 18, 19.8 and 21.6 m^2, respectively, which corresponds sizes of squares of 10x10 and 11x11, for 1.8 and 3.6m^2 plot sizes and 9x9 size of square, for 5.4, 7.2 and 9m^2 plot sizes and 8x8 size of square for plot size 10.8 m^2 and 7x7 size of square for 12.6 and 14.4 m^2 and 6x6 size of square for 16.2, 18 and 19.8 m^2 and 5x5 size of square for 21.6 m^2 plot size. The results scored critical limit of coefficient of variation (C.V ≤ 15%) of 15, 15.11, 14.58, 12.91, 13.91, 6.38, 7.98, 8.01, 6.94, 6.34, 13.5 and 11.4 % in the first season and 14.92, 14.4, 14.6, 13.5, 12.5, 12.14, 10.16, 12.04, 11.12, 15, 13.5 and11.14% in the second season for corresponding sizes of plot respectively.

Results in Table 3 indicated that the critical limit of significance (≤ 5%) between plot means were 0.057, 0.09, 0.069, 0.288, 0.088, 0.43, 0.056, 0.094, 0.802, 0.31, 0.09 and 0.059 in the first season and 0.089, 0.096, 0.064, 0.372, 0.072, 0.92, 0.342, 0.182, 0.068, 0.075, 0.19 and 0.087 in the second seasons for the selected combinations. These critical values cleared the significance between plot yield averages.

The averages of row were considered as samples and estimated from 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 rows per plot. The averages were 4.910, 5.629, 4.740, 4.893, 4.803, 4.664, 4.948, 4.987, 4.428, 4.670, 4.124 and 3.908kg/row in the first season and 4.869 and 5.023, 5.201 and 5.35, 4.9, 4.776, 4.376, 4.965, 5.537, 3.789, 3.517, 4.287, 5.214 and 3.879kg/row in the second season for corresponding plot sizes.

The previous results indicated the homogeneity of the experimental soil field and accuracy of the results which increase the efficiency of onion experiments.

The results obtained are in agreement with those of Chica and Rodriquez (1967), Abou EL-Fittouh (1977), El-Kalla *et. al.* (1981), Abd EL-Halim *and Saad* (1989), Surin (1992), EL-Taweel (1999), Barakat (2002), EL-EL-Taweel (2004) and Ragab *et. al.* (2006).

Table 4 represents the selected combinations from sizes of squares, samples, plots and their probabilities of significance between plot means, coefficients of variation (C.V) and relative efficiency (RE).

Table 3: Size of squares, sample size (number of rows/plot), number of analyzed experiments, plot sizes, plot means, probability of significance between plot means (treatment means), coefficient of variation (C.V.) and relative efficiency (R.E.) for onion trials in 2004/2005 and 2005/2006 seasons.

No. of squares	Sample size	Plot sizes	number of analyzed experiments	Yield averages of row/plots kg		Probability of significant for plot mean		Coefficient of variation (C.V. %)		Relative efficiency (R.E. %)	
				2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
3 x 3	1	1.8 m^2	192	3.844	3.165	0.896	2.512	10.48	10.2	106	95.14
4 x 4	"	"	108	3.919	3.641	0.954	2.153	10.52	11.6	110	99.12
5 x 5	"	"	69	4.46	3.811	0.302	2.014	11.14	12.4	112	103.12
6 x 6*	"	"	48	3.42	3.966	0.201	1.08	12.94	12.49	116	108.9
7 x 7	"	"	35	3.736	4.157	0.180	0.987	12.51	13.5	119	125
8 x 8	"	"	27	3.261	4.356	0.102	0.654	13.99	14.09	121	109.3
9 x 9	"	"	18	3.526	4.542	0.089	0.428	14.66	14.15	123	113.54
10x10	"	"	17	4.910	*4.869*	0.057	0.249	15.00	14.52	126	118.14
11x11	"	"	14	4.642	5.023	0.000**	0.089	20.00	14.92	104	122.48
12x12	"	"	12	4.811	4.901	0.000**	0.042*	25.74	15.87	92	105.124
3 x 3	2	3.6 m^2	96	4.189	4.523	0.240	3.587	17.12	11.46	91.78	91.6
4 x 4	"	"	54	4.291	4.312	0.138	3.427	17.9	11.63	92	95.24
5 x 5	"	"	34	4.46	4.624	0.137	3.561	18.58	12.57	102.25	98.47
6 x 6	"	"	24	4.331	4.89	0.381	2.150	11.61	12.18	109.45	100.89
7 x 7	"	"	17	4.319	4.889	0.450	2.452	12.05	13.321	111.07	103.15
8 x 8	"	"	13	4.582	4.69	0.190	2.024	10.71	14.02	119.26	108.6
9 x 9	"	"	9	4.809	54.995	0.180	1.952	14.58	14.02	123.96	110.48
10x10	"	"	8	5.629	5.201	0.09	1.04	15.11	*14.4*	127.61	119.5
11x11	"	"	7	5.465	5.35	0.006**	0.0956	16.88	15.03	106.00	130.20
12x12	"	"	6	5.489	5.222	0.000**	0.0501*	17.48	17.1	104.23	109

Table 3. Cont.

No. of squares	Sample size	Plot sizes	number of analyzed experiments	Yield averages of row/plots kg		Probability of significant for plot mean		Coefficient of variation (C.V. %)		Relative efficiency (R.E. %)	
				2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
3 x 3	3	5.4 m^2	64	2.911	3.801	0.914	2.145	19.35	7.61	75.53	85
4 x 4	"	"	36	3.283	3.844	0614	1.254	19.86	7.02	82.10	92
5 x 5	"	"	23	3.617	3.933	0.450	0.148	15.59	10.4	87.69	102
6 x 6	"	"	16	4.016	3.950	0.270	0.144	16.84	11.7	98.11	112
7 x 7	"	"	11	4.289	4.111	0.187	0.268	14.31	12.3	107.43	115
8 x 8	"	"	9	4.462	4.266	0.156	0.095	13.6	132	112.14	117
9 x 9	"	"	**6**	**4.740**	**4.9000**	**0.069**	**0.064**	***14.58***	**14.6**	**133.35**	**126**
10x10	"	"	4	4.558	4.864	0.028*	0.000**	16.13	15.87	111.43	105
11x11	"	"	4	4.523	3.26	0.000**	0.000**	18.27	17	108.33	109
12x12	"	"	3	4.308	3.7	0.000**	0.000**	20.49	19	101.24	89
3 x 3	4	7.2m^2	48	3.981	3.465	0.052	3.111	6.51	10.42	90.10	67
4 x 4	"	"	27	4.055	4.076	0.147	2.223	7.30	12.13	123.03	89
5 x 5	"	"	17	4.107	3.876	0.049	0.174	7.07	13.4	129.45	95
6 x 6	"	"	12	4.127	3.888	0.055	0.167	9.29	13.01	126.72	104
7 x 7	"	"	8	4.105	4.400	0.375	0.409	9.96	13.2	130.68	118
8 x 8	"	"	6	4.289	4.295	0.284	0.370	12.18	13.65	131.40	122
9 x 9	"	"	**4**	**4.893**	**4.776**	**0.288**	***0.372***	**12.91**	**13.5**	**149.64**	**133**
10x10	"	"	4	4.701	4.360	0.030*	0.000**	16.12	15.8	117.15	130
11x11	"	"	3	4.225	3.900	0.000**	0.000**	17.56	16.7	109.23	112
12x12	"	"	3	4.094	4.542	0.000**	0.000**	18.63	18.9	104.28	109

Table 3. Cont.

No. of squares	Sample size	Plot sizes	number of analyzed experiments	Yield averages of row/plots kg		Probability of significant for plot mean		Coefficient of variation (C.V. %)		Relative efficiency (R.E. %)	
				2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
3 x 3	5	9 m^2	38	3.871	3.936	0.276	3.306	8.06	11.18	106.63	85
4 x 4	"	"	21	3.983	3.736	0.146	2.253	7.22	11.10	111.38	92
5 x 5	"	"	13	4.113	3.893	0.095	1.325	7.88	12.14	141.6	98
6 x 6	"	"	9	4.303	4.012	0.69	1.023	7.13	12.06	143.17	102
7 x 7	"	"	7	4.362	4.244	1.357	0.085	7.36	12.58	159.54	119
8 x 8	"	"	5	4.442	4.393	0.190	0.062	7.50	14.01	162.84	123
9 x 9	"	"	**4**	**4.803**	**4.376**	**0.088**	**.072**	**13.91**	**12.5**	**145.64**	**129**
10x10	"	"	3	4.849	4.257	0.040*	0.000**	9.01	16.47	137.30	121
11x11	"	"	2	4.050	3.993	0.000**	0.000**	11.34	18.98	124.79	106
12x12	"	"	2	4.991	3.260	0.000**	0.000**	11.21	18.47	107.19	101
3 x 3	6	10.8 m^2	32	3.820	4.218	3.390	3.393	4.31	9.12	117.21	76
4 x 4	"	"	18	3.898	5.525	3.034	2.357	6.52	9.18	134.53	85
5 x 5	"	"	11	3.998	4.062	2.800	2.126	5.52	11.15	143.95	91
6 x 6	"	"	8	4.091	4.425	1.860	2.010	6.23	12.43	149.41	96
7 x 7	"	"	6	4.036	4.851	0.980	1.561	7.23	13.14	155.51	101
8 x 8	"	"	**4**	**4.664**	**4.965**	**0.430**	**0.92**	**6.38**	**12.14**	**193.97**	**111**
9 x 9	"	"	3	4.308	3.99	0.020*	0.0512	7.13	14.89	132.44	102
10x10	"	"	2	4.730	4.393	0.000**	0.000**	8.08	16.78	125.04	94
11x11	"	"	2	5.186	4.697	0.000**	0.000**	9.48	16.94	109.51	93
12x12	"	"	2	5.276	4.018	0.000**	0.000**	9.13	17.24	109.43	91

Table 3. Cont.

No. of squares	Sample size	Plot sizes	number of analyzed experiments	Yield averages of row/plots kg		Probability of significant for plot mean		Coefficient of variation (C.V. %)		Relative efficiency (R.E. %)	
				2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
3 x 3	7	12.6 m^2	27	3.770	4.142	0.416	2.570	3.80	6.13	86.39	88
4 x 4	"	"	15	3.825	4.642	0.520	2.375	8.39	6.08	116.19	93
5 x 5	"	"	9	3.901	5.22	0.354	1.338	6.87	9.17	125.21	98
6 x 6	"	"	6	3.97	5.172	0.2012	0.998	6.97	10.42	129.093	102
7 x 7	"	"	**5**	**4.948**	**5.537**	**0.056**	**0.342**	**7.78**	**10.16**	**150.58**	**125**
8 x 8	"	"	3	4.001	5.392	0.002**	0.0423	7.74	12.59	137.98	136
9 x 9	"	"	2	4.243	4.595	0.000**	0.000**	7.45	15.48	108.82	120
10x10	"	"	2	4.657	4.899	0.000**	0.000**	6.97	15.35	101.66	109
11x11	"	"	2	5.083	5.206	0.000**	0.000**	8.64	16.01	102.36	101
12x12	"	"	1	5.172	4.811	0.000**	0.000**	11.79	15.98	102.38	98
3 x 3	8	14.4 m^2	24	3.960	3.111	0.424	3.997	4.61	10.87	80.68	84
4 x 4	"	"	13	3.871	3.978	0.381	3.985	7.13	11.14	128.49	104
5 x 5	"	"	8	3.959	3.457	0.173	2.347	6.62	11.97	131.62	124
6 x 6	"	"	6	4.036	3.555	0.112	2.425	7.82	12.54	136.22	138
7 x 7	"	"	**4**	**4.987**	**3.789**	**0.094**	**0.182**	**8.01**	**12.04**	**145.24**	**149**
8 x 8	"	"	3	4.025	4.354	0.001**	0.032	7.48	15.74	120.82	116
9 x 9	"	"	2	4.263	3.600	0.000**	0.000**	7.53	16..26	109.64	105
10x10	"	"	2	4.647	3.824	0.000**	0.000**	7.39	16.42	101.92	101
11x11	"	"	1	5.06	3.690	0.000**	0.000**	11.12	18.24	102.61	98
12x12	"	"	1	5.665	3.512	0.000**	0.000**	15.90	19.67	100.77	99

Table 3. Cont.

No. of squares	Sample size	Plot sizes	number of analyzed experiments	Yield averages of row/plots kg		Probability of significant for plot mean		Coefficient of variation (C.V. %)		Relative efficiency (R.E. %)	
				2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
3 x 3	7	12.6 m^2	27	3.770	4.142	0.416	2.570	3.80	6.13	86.39	88
4 x 4	"	"	15	3.825	4.642	0.520	2.375	8.39	6.08	116.19	93
5 x 5	"	"	9	3.901	5.22	0.354	1.338	6.87	9.17	125.21	98
6 x 6	"	"	6	3.97	5.172	0.2012	0.998	6.97	10.42	129.093	102
7 x 7	"	"	**5**	**4.948**	**5.537**	**0.056**	**0.342**	**7.78**	**10.16**	**150.58**	**125**
8 x 8	"	"	3	4.001	5.392	0.002**	0.0423	7.74	12.59	137.98	136
9 x 9	"	"	2	4.243	4.595	0.000**	0.000**	7.45	15.48	108.82	120
10x10	"	"	2	4.657	4.899	0.000**	0.000**	6.97	15.35	101.66	109
11x11	"	"	2	5.083	5.206	0.000**	0.000**	8.64	16.01	102.36	101
12x12	"	"	1	5.172	4.811	0.000**	0.000**	11.79	15.98	102.38	98
3 x 3	8	14.4 m^2	24	3.960	3.111	0.424	3.997	4.61	10.87	80.68	84
4 x 4	"	"	13	3.871	3.978	0.381	3.985	7.13	11.14	128.49	104
5 x 5	"	"	8	3.959	3.457	0.173	2.347	6.62	11.97	131.62	124
6 x 6	"	"	6	4.036	3.555	0.112	2.425	7.82	12.54	136.22	138
7 x 7	"	"	**4**	**4.987**	**3.789**	**0.094**	**0.182**	**8.01**	**12.04**	**145.24**	**149**
8 x 8	"	"	3	4.025	4.354	0.001**	0.032	7.48	15.74	120.82	116
9 x 9	"	"	2	4.263	3.600	0.000**	0.000**	7.53	16..26	109.64	105
10x10	"	"	2	4.647	3.824	0.000**	0.000**	7.39	16.42	101.92	101
11x11	"	"	1	5.06	3.690	0.000**	0.000**	11.12	18.24	102.61	98
12x12	"	"	1	5.665	3.512	0.000**	0.000**	15.90	19.67	100.77	99

Table 3. Cont.

No. of squares	Sample size	Plot sizes	number of analyzed experiments	Yield averages of row/plots kg		Probability of significant for plot mean		Coefficient of variation (C.V. %)		Relative efficiency (R.E. %)	
				2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
3 x 3	11	19.8 m^2	17	4.350	5.384	2.299	0.593	5.68	11.16	96.57	98
4 x 4	"	"	9	3.781	5.062	2.067	0.492	5.25	11.89	111.77	108
5 x 5	"	"	6	3.944	4.96	1.002	0.375	5.71	12.14	114.24	112
6 x 6	"	"	**4**	**4.124**	**5.214**	**0.090**	**0.19**	**5.69**	**13.5**	**114.87**	**119**
7 x 7	"	"	3	4.142	4.98	0.000**	0.000**	6.38	15.28	107.58	110
8 x 8	"	"	2	4.179	4.358	0.000**	0.000**	6.30	15.16	1106.50	105
9 x 9	"	"	1	4.391	4.865	0.000**	0.000**	6.57	17.08	102.78	107
10x10	"	"	1	4.689	4.002	0.000**	0.000**	6.78	16.87	101.62	100
11x11	"	"	1	4.379	4.075	0.000**	0.000**	11.02	17.42	103.59	101
12x12	"	"	1	5.758	4.350	0.000**	0.000**	8.68	18.04	102.82	100
3 x 3	12	21.6 m^2	16	4.650	3.529	0.370	0.910	5.63	9.78	108.21	97
4 x 4	"	"	9	3.741	4.125	0.223	0.186	4.73	10.16	110.84	105
5 x 5	"	"	**5**	**3.908**	**3.897**	**0.059**	**0.087**	**5.45**	**11.14**	**111.59**	**127**
6 x 6	"	"	4	4.088	3.931	0.000**	0.005**	5.59	15.87	103.68	119
7 x 7	"	"	2	4.128	3.807	0.000**	0.000**	5.96	16.97	101.26	107
8 x 8	"	"	2	4.187	4.195	0.000**	0.000**	5.54	16.49	100.14	106
9 x 9	"	"	1	4.397	4.085	0.000**	0.000**	6.11	17.54	97.96	101
10x10	"	"	1	4.668	3.618	0.000**	0.000**	6.68	18.90	91.76	94
11x11	"	"	1	4.469	3.855	0.000**	0.000**	10.08	18.70	87.61	98
12x12	"	"	1	4.799	4.217	0.000**	0.000**	9.47	19.47	90.88	99

Table 4: Derived from Table 3.

No. of squares	Sample size	Plot sizes	number of analyzed experiments	Yield averages of row/plots kg		Probability of significant for plot mean		Coefficient of variation (C.V. %)		Relative efficiency (R.E. %)	
				2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
10x10	1	1.8 m^2	17	4.910		0.057		15.00		126	
11x11	1	"	14		5.023		0.089		14.92		122.48
10x10	2	3.6 m^2	8	5.629		0.09		15.11		127.61	
11x11	2	"	7		5.35		0.096		15.03		130.20
9 x 9	3	5.4 m^2	6	4.740	4.9000	0.069	0.064	14.58	14.6	133.35	126
9 x 9	4	7.2 m^2	4	4.803	4.776	0.288	.372	12.91	13.5	149.64	133
9 x 9	5	9 m^2	4	4.803	4.376	0.088	.072	13.91	12.5	145.64	129
8 x 8	6	10.8 m^2	4	4.664	4.965	0.430	0.92	6.38	12.14	193.97	111
7 x 7	7	12.6 m^2	5	4.948	5.537	0.056	0.342	7.78	10.16	150.58	125
7 x 7	8	14.4 m^2	4	4.987	3.789	0.094	0.182	8.01	12.04	145.24	149
6 x 6	9	16.2 m^2	5	4.428	3.517	0.802	0.068	6.94	11.12	132.03	126
6 x 6	10	18 m^2	4	4.67	4.287	0.310	0.075	6.34	15.00	124.98	142
6 x 6	11	19.8 m^2	4	4.124	5.214	0.190	0.090	5.69	13.5	114.87	119
5 x 5	12	21.6 m^2	5	3.908	3.897	0.059	0.087	5.45	11.14	111.59	127

Generally, changing of plot size led to change of square size and, in turn, changing RE, C.V and critical limit of significance between plot means in the two seasons. This change gives researcher a chance to determine his optimum combinations from sizes of squares and plots depending upon variability of his variables, nature of his treatments and their costs. Also, researcher can depend upon maximum gain of precision (RE), critical limit of coefficient of variation (C.V) and critical limit of significance between plot means for indicating the homogeneity of the experimental field and these measures could be considered as tools of homogeneity of field trials.

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دراسات على تكنيك القطعة لتصميم المربع اللاتينى فى تجارب البصل

على محمد سيد احمد الطويل و سمية احمد محمد بركات
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أقيمت تجربتي تجانس في محطة بحوث سدس بمحافظة بني سويف خلال موسمي ٢٠٠٤/٢٠٠٥ وكذلك ٢٠٠٥/٢٠٠٦ حيث تم شتل التجربتين في ١٠ ، ١٩ يناير بالصنف جيزة ٢٠ وطبقت كل المعاملات الزراعية الموصى بها في تلك التجارب. وكانت مساحة الحقل التجريبي لكل تجربة ٣١١٠,٤ متر مربع (٠,٧٤١ فدان) قسمت إلى ١٢ شريحة بكل شريحة ١٤٤ خط بعدد كلى ١٧٢٨ خط للتجربة. وقد تم حصاد كل خط على حدة وكان حجم العينات المستخدمة لحساب متوسط كل عينه هو محصول ١، ٢، ٣، ٤، ٥، ٦، ٧، ٨، ٩، ١٠، ١١، ١٢، خط وقد تم استخدام أعلى كفاءة نسبية والحد الحرج لمعامل الاختلاف اقل من او يساوى ١٥ % والحد الحرج لاحتمال المعنوية اقل من او يساوى ٥ % لتقدير العلاقة إذا اختلفت مساحات المربع والقطع التجريبية وحجم العينات. وقد تم حساب الكفاءة النسبية للمربع اللاتيني منسوبا إلى التصميم التام العشوائية حيث الخير يفترض تجانس الحقل التجريبي. وقد أشارت النتائج إلى أن التغير في مساحة القطعة التجريبية له علاقة بحجم المربع حيث يظهر ذلك جليا في قيم الكفاءة النسبية وقيم احتمالات المعنوية بين متوسطات القطع التجريبية وكذلك قيم معامل الاختلاف فخلال موسمي التجربة كما أوضحت النتائج إلى أن انسب التوليفات من مساحات المربعات ومساحات القطع كانت ١٠ X ١٠ ، ١١ X ١١ مع مساحة قطعة ١,٨ ، ٣,٦ متر مربع ، ٩ X ٩ مساحة مربع مع ٤,٥ ، ٧,٢ ، ٩ متر مربع ، ٨ X ٨ مساحة مربع مع ١٠,٨ متر مربع لمساحة القطعة ، ٧ X ٧ مساحة مربع مع مساحتي قطعة ١٢,٦ ، ١٤,٤ متر مربع ، ٦ X ٦ مساحة مربع مع مساحتي قطعة ١٦,٢ ، ١٨ ، ١٩,٨ متر مربع ، ومساحة مربع ٥ X ٥ مع مساحة قطعة ٢١,٦ متر مربع. كما سجلت النتائج أيضا أعلى معدلات للدقة للمربع اللاتيني مع التوليفات السابقة وكانت ٢٦ ، ٢٧,٦١ ، ٣٣,٣٥ ، ٤٩,٦٤ ، ٤٥,٦٤ ، ٩٣,٩٧ ، ٥٠,٥٨ ، ٤٥,٢٤ ، ٣٢,٠٣ ، ٢٤,٤٨ ، ١٤,٨٧ ، ١١,٥٩ % في الموسم الأول وسجلت هذه المعدلات ٢٢,٤٨ ، ٣٠,٢ ، ٢٦ ، ٣٣ ، ٢٩ ، ١١ ، ٢٥ ، ٤٩ ، ٢٦ ، ٤٢ ، ١٩ ، ٢٧ % في الموسم الثاني وسجلت هذه المعدلات مع مساحات للقطع التجريبية هي ١,٨ ، ٣,٦ ، ٤,٥ ، ٧,٢ ، ٩ ، ١٠,٨ ، ١٢,٦ ، ١٤,٤ ، ١٦,٢ ، ١٨ ، ١٩,٨ ، ٢١,٦ متر مربع على الترتيب. وقد أوضحت النتائج أيضا أن قيم معامل الاختلاف الحرجة كانت في حدود الأمان للتجارب الحقلية وقد تراوحت بين ١٥، ٦,٣٤ % في الموسم الأول وتراوحت بين ١٥ ، ١٠,١٦ % في الموسم الثاني. وقد سجلت أيضا النتائج القيم الحرجة لاحتمالات المعنوية بين متوسطات القطع التجريبية قد تراوحت بين ٠,٢٨٨ ، ٠,٠٧٥ في الموسم الأول كما قد تراوحت بين ٠,٣٤٢ ، ٠,٠٦٤ في الموسم الثاني.

ومن النتائج السابقة يكون لدى للباحث الفرصة في تحديد التوليفة المثلى من مساحة المربع ومساحة القطعة التجريبية التي تتلاءم مع طبيعة الصفة تحت الدراسة وطبيعة المعاملة المختبرة على قدر ما يتحمل من تكاليف وذلك مع إعطاء الباحث فرصة الحصول على أعلى دقة للنتائج وعلى كفاءة للتصميم وذلك في ظل الحد الأمن من معامل الاختلاف وضمان شيوع التجانس في حقل التجربة.