J. Agric. Sci. Mansoura Univ., 31 (4): 1891 - 1912, 2006

STUDY THE EFFECT OF INTERRELATION AMONG NUMBER OF PLOTS, BLOCKS, SAMPLES AS WELL AS THEIR SIZES ON EFFICIENCY AND ACCURACY OF EXPERIMENTS IN SORGHUM .

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ABSTRACT

Soil variability affects experimental results and we can minimize this effect by choosing a proper design and the use of optimum number of plots, blocks, samples as well as their sizes. This study aimed to investigate effect of these *interrelationships on experimental and sampling errors*, relative efficiency and coefficient of variation (C.V) as measures of accuracy for randomized complete block design in sorghum experiments. Two uniformity trail were conducted at Shandweel Agricultural Research Station, *Sohag Governorate during 2004 and 2005 seasons*. Dorado variety was used in both seasons. Total field area was 2287.5 m^2 (0.545 feddan) for each trial that divided into 6 strips consisted of 120 ridges each considering ridge as the basic unit. *Samples consisting of 5, 10, 15, 20, and 25* plants and data were assigned in randomized complete block design with different number of plots (k), blocks (b), sample (s) as well as their sizes in the two seasons.

Results cleared that increasing sample size and *number of blocks led to* increase relative efficiency. Increasing number of plots per block, with number of blocks and size of sample also led to increase relative efficiency and precision of the analysis. Results also cleared that the optimum combinations were 2,3 and 4 blocks of area 97.2, 129.6 and 144 m^2 with number of plots of 9, 12 and 16 plot per block of area 10.8, 10.8 and 9 m^2 as plot sizes and 25, 25 and 20 plants as size of sample, respectively. These combinations scored RE equal to 190, 197and 230% in first season and 149, 173 and 217% in second season, respectively. The coefficient of variation (C.V.) estimates scored 13.62, 8.64 and 7.22 % in first season and 11.45, 10.34 and 6.04 % in the second season, respectively. These results also showed that number of blocks is inversely proportional with sample size.

Experimental (E) and sampling (S) errors values also compared with each other to estimate the optimum sample size. Results cleared that sampling error scored 0 075, 0.127 and 0.234 in first season and 0.254, 0.124 and 0.208 in second season while experimental error scored 0.326, 0.256 and 0.738 in the first season and 0.424, 0.333 and 0.959 in the second season for 2,3 and 4 blocks, respectively, these indicating homogeneity of sample size .

INTRODUCTION

Sensitivity of experimental results is affected by soil variability as a major factor. A great deal of the soil 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. This emphasizes* the importance of determining soil variability in experimental fields, and estimating the optimum block and plot size, as well as number of replications in these fields. The uniform plots and blocks are very important to detect the true differences between treatment means. The size of block, number of plots per block and number of samples per plot depends upon degree of soil homogeneity. Several factors

have to be taken into consideration as soil type, number of replications, number of samples, optimum plot size and the efficiency of experimental design. Interrelation between these factors makes it extremely difficult to take only a single factor under consideration. Previous reports investigated all these factors separately for different crops except sorghum and this study aimed to detect their interrelations. Moreover, this study gives researchers the chance to choose optimum combinations of block and plot sizes, number of replications and sample size for randomized complete block design with a lower cost and sizable gain in precision. Also, this study will be useful for breeders, agronomists who concern with improving the experimental results of sorghum *(Sorghum bicolor (L.) Moench)*. Charles and Mason (1959) reported that the necessary number of replications to obtain a least significant difference of 15% of the mean yield of soybean was estimated as 9,5 and 4 for 1, 2, 3, 6 and 4 basic units, respectively. Rampton and Petersen (1962) on orchardgrass, showed that, increasing number of replications permitted detection of smaller differences in yield. Torrie *et.al.* (1963) on alfalfa – bromegrass mixtures, found that number of replicates required to detect differences among treatments decreased with the increase in plot size. Galal and Abou El-Fittouh (1971) on cotton, estimated optimum plot size as 18 to 29 m^2. Also results pointed out that the sensitivity of the experiment to detect specified magnitude between means was affected by increasing the plot size. Khalil *et.al.* (1971) on cotton yield trials, found that the optimum plot size ranged from 1/600 feddan and 1/300 feddan and from 1/300 to 1/200 feddan for Gemmeiza and Sids locations, respectively. Abou-El-Fittouh (1976) reported that the value obtained for relative efficiency indicates that randomized complete blocks design is more efficient than the completely randomized design for different crops. Cochran (1977) estimated the optimum sample size by minimizing the expected product of cost and variance components. El-Kalla and Gommaa (1977) reported an optimum plot size for wheat which was 3.0 m^2 (1/1400 fed), using Smith's procodure in Gemmeiza and Sids. However, it was 7.0 and 5.0 m by using modified maximum curvature technique for the previous two locations, respectively. EL- Rassas (1982) on wheat, found that the optimum plot size ranged from 4 to 8 basic units with 1/300 to 1/500 feddan. Casler and Ehike (1985) reported that increasing sample size increases precision, but also increases the cost. Lin and Binns (1986) in their study on relative efficiency of two randomized blocks design with different plot size and number of plots per block. They reported that the purpose was to use information of past experiments to improve the proposed design or through increasing the plot size. Lefoet (1987) provided that, the efficiency of comparisons between treatment means are particularly related to the size and number of experimental units. Nasr (1991) found that the convenient number of samples were various from one character to the other and number of sample size ranged from 6 to 80 samples. Surin (1992) studied the sensitivity of statistical tests to detect the differences between treatment means. He found that, when the sample size ranges from 20 to 24 plants causes higher efficiency in estimation than simple random sampling. EL- Rayes *et.al.* (1993) working on wheat, concluded that increasing plot size decreased the variance per basic units

and the optimum plot size ranged from 1/1000 to 1/750 feddan. Zedaker, *et.al.* (1993) reported that, the ability to detect small differences between treatment means depends on relation among sample size, type I and II errors probability and coefficient of variability of the data. Poultney and Webster (1997) showed that, the optimum plot size ranged from 1x1 m to 4x4 m^2, they studied optimum plot size and shapes for field experiments on trasses. Wei Wei *et.al.* (2001) mentioned that, the amount of replication depends on the size of treatment differences (plot differences) to detect the variation in the data. Ashmawy *et.al.* (2003) recommended that the optimum plot size was 4 sample units being 2.8 m^2 in wheat. 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.

MATERIALS AND METHODS

To determine optimum number of plots, blocks and sample as well as their sizes for randomized complete block design in sorghum, two uniformity trials were conducted at Shandweel Agricultural Research Station, Sohag Governorate during 2004 and 2005 seasons. Dorado variety was used in both seasons and all recommended practices were done as usual in sorghum fields. The total field area was 30.5 X 75 m (2287.5 m^2 =0.545 feddan) for each trial and the area was divided into 6 strips. Each strip was consisted of 120 ridges with 3 m long and 60 cm apart (1.8 m^2) considering the ridge as the basic unite. Consequently, a total of 720 basic experimental units were used for each trial which was done in June 10^{th} and 19^{th}. Distance between hills was 15 cm, plants were thinned to two plants/hill after 20 days from sowing. Plants were harvested in October 10^{th} and 19^{th} in 2004 and 2005 seasons, respectively. Each basic unit (row) was harvested separately after discarding two plants from each end to eliminate the border effect. Samples consisted of 5, 10, 15, 20, and 25 plants which were chosen by random from each plot. Data were assigned in randomized complete block design with different combinations of plots (k), blocks (b), sample (s) as well as their sizes in the two seasons as shown in Table 1.

Statistical analysis:

Block and plot sizes were obtained by using a long grouping of basic units (rows) of each strip. Number of plots were calculated by dividing the total number of basic units (720 units) by number of basic units per plot x number of plots per block x number of blocks.

The interrelations among number of plots, blocks, sample as well as their sizes were studied based on experimental and sampling errors, relative efficiency and coefficient of variation (C.V) in the two seasons .

Table 1: Number of plots (k), blocks (b), samples (s) as well as their sizes and number of experiments analyzed in 2004 and 2005 seasons.

Numbers of plots (k)	No.of blocks (b)	No.of samples (S)	Block size m^2	Plot size m^2	Sample size	No. of experimental units analyzed
2	2,3,4	2,3,4,5,6	7 2,10 8,14.4,18,21.6	3.6,5.4,7.2,9,10 8	5,10,15,20,25	150,100,75,60,50
3	2,3,4	2,3,4,5,6	10.8,16.2,21.6,27,32.4	3.6,5.4,7.2,9,10.8	5,10,15,20,25	100,66,50,40,33
4	2,3,4	2,3,4,5,6	14.4,21 6,28 8,36,43 2	3.6,5 4,7.2,9,10.8	5,10,15,20,25	75,50,37,30,25
5	2,3,4	2,3,4,5,6	18,27,36,45,54	3.6,5 4,7 2,9,10.8	5,10,15,20,25	60,40,30,24,20
6	2,3,4	2,3,4,5,6	21.6,32.4,43.2,54	3.6,5.4,7 2,9,10 8	5,10,15,20,25	50,33,25,20,16
7	2,3,4	2,3,4,5,6	25.2,37.8,50 4,63,75.6	3.6,5.4,7.2,9,10 8	5,10,15,20,25	42,28,21,17,14
8	2,3,4	2,3,4,5,6	28.8,43.2,57 6,72	3.6,5.4,7.2,9,10 8	5,10,15,20,25	37,25,18,15,12
9	2,3,4	21,3,4,5,6	32.448.6,64 8,81,97.2	3.6,5.4,7.2,9,10.8	5,10,15,20,25	33,22,16,13,11
10	2,3,4	2,3,4,5,6	36,54,72,90,108	3.6,5 4,7.2,9,10 8	5,10,15,20,25	30,20,15,12,10
11	2,3,4	2,3,4,5,6	39 6,59 4,79 2,99,118 8	3.6,5 4,7.2,9,10 8	5,10,15,20,25	27,18,13,10,9
12	2,3,4	2,3,4,5,6	43.2,64.8,86 4,108,129 5	3.6,5.4,7 2,9,10 8	5,10,15,20,25	25,16,12,10,8
13	2,3,4	2,3,4,5,6	46 8,70 2,93.6,117,140 4	3.6,5.4,7 2,9,10 8	5,10,15,20,25	23,15,11,9,7
14	2,3,4	2,3,4,5,6	50 4,75.6,100 8,126,151 2	3 6,5.4,7.2,9,10 8	5,10,15,20,25	21,14,10,8,7
15	2,3,4	2,3,4,5,6	54,81,108,135,162	.6,5,5.4,7 2,9,10 8	5,10,15,20,25	20,13,10,8,6
16	2,3,4	2,3,4,5,6	57.6,86 4,115.2,144,172.8	3.6,5.4,7.2,9,10 8	5,10,15,20,25	18,12,9,7,6
17	2,3,4	2,3,4,5,6	61 2,91 8,122.4,153,183.6	3.6,5 4,7.2,9,10.8	5,10,15,20,25	17,11,8,7,5
18	2,3,4	2,3,4,5,6	64 8,97 2,129.6,162,194 4	3 6,5.4,7.2,9,10.8	5,10,15,20,25	16,11,8,6,5
19	2,3,4	2,3,4,5,6	68.4,102 6,136.8,171,205.2	3.6,5.4,7.2,9,10.8	5,10,15,20,25	15,10,7,6,5
20	2,3,4	2,3,4,5,6	72,108,144,180,216	3.6,5.4,7.2,9,10 8	5,10,15,20,25	15,10,7,6,5

The relative efficiency (RE) related to completely randomized design (CRD) was estimated as follows:

$$RE\ (RCBD / CRD) = \frac{MSe_2(n_1+1)(n_2+3)}{MSe_1(n_2+1)(n_1+3)} \times 100$$

Where:

MSe_1 = mean square error for RCBD.

MSe_2 = mean square error for CRD.

n_1 and n_2 = error degrees of freedom for the RCBD and CRD designs, respectively.

The statistical analysis of variance for randomized complete block design (RCBD) was done as outlined by Steel and Torrie (1980) with sub sample analysis as shown in Table 2 .

Table 2: Sources of variation, for randomized complete block design with sub sampling analysis.

Source of variance	Degrees of freedom	Expected mean square
Blocks	b-1	
Treatments	k-1	$\sigma^2_s + n\sigma^2_e + nb(\sum k^2_i)/(k-1)$
Experimental error	(b-1)(k-1)	$\sigma^2_s + n\sigma^2_e$
Sampling error	bk(s-1)	σ^2_s

Where: b = blocks, k = treatments (number of experimental units), s = samples

RESULTS AND DISCUSSION

Table 3 cleared results of experimental and sampling errors, relative efficiency (RE) and coefficient of variation (C.V) as affected by the interrelation among number of plots (k), blocks (b), samples (s) as well as their sizes in the two seasons.

Relative efficiency (RE) was used as indicator for experimental precision and gain of the analysis compared with CRD design for all combinations as shown in Table 3. These relations cleared that increasing sample size and number of blocks led to increase relative efficiency. Increasing number of experimental units per block, number of blocks and number of samples also led to increase efficiency and precision of the analysis.

Using Table 3, we can choose the optimum combinations from number of plots (k), blocks (b), samples (s) as well as their sizes when relative efficiency started to be greater than or equal (≥) 100%. Italic, underline and bold face clear these combinations . Results indicated that starting with these combinations true effects between plots can be detected. Table 3 also clears that increasing sample size and number of blocks more than selected numbers, also gave continue increase in relative efficiency.

The results showed that 1) 2 blocks with area of 97.2 m^2, 9 plots/block with plot area of 10.8 m^2 and a sample size of 25 plants, 2) 3 blocks with area of 129.6 m^2, number of plots/block of 12 with plot area being 10.8 m^2 and 25 plants as sample size and 3) 4 blocks with area a of 144 m^2, 16 plots/block with plot size of 9 m^2 and sample size of 20 plants/plot as sample size were the optimum combinations in the two seasons of the study.

Table 3: Experimental and sampling errors, relative efficiency and coefficient of variation (C.V) as affected by interrelation among number of plots (k), blocks (b), samples (s) as well as their sizes in 2004 and 2005 seasons.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
2	2	2	7.2	3.6	5	90	0.163	0.2119	0.132	0.002	95	75	15.569	17.947
2	2	3	10.8	5.4	10	60	0.141	0.1833	0.125	0.006	86	82	15.352	17.647
2	2	4	14.4	7.2	15	45	0.125	0.1625	0.013	0.0156	90	87	15.099	16.285
2	2	5	18	9	20	36	0.114	0.1482	0.009	0.030	105	95	14.588	16.555
2	2	6	21.6	10.8	25	30	0.108	0.1404	0.007	0.044	109	102	14.770	14.815
3	2	2	10.8	3.6	5	60	0.305	0.3965	0.217	0.020	84	79	16.167	18.810
3	2	3	16.2	5.4	10	40	0.282	0.3666	0.195	0.042	86	82	15.742	18.203
3	2	4	21.6	7.2	15	30	0.24	0.312	0.130	0.044	91	97	15.401	17.717
3	2	5	27	9	20	24	0.212	0.2756	0.056	0.067	109	99	15.062	16.232
3	2	6	32.4	10.8	25	20	0.193	0.2613	0.042	0.074	114	101	14.712	15.732
4	2	2	14.4	3.6	5	45	0.201	0.4108	0.262	0.074	90	82	16.241	18.917
4	2	3	21.6	5.4	10	30	0.309	0.4016	0.210	0.252	92	87	16.199	18.856
4	2	4	28.8	7.2	15	22	0.207	0.2691	0.176	0.211	94	92	16.103	18.719
4	2	5	36	9	20	18	0.259	0.3367	0.156	0.307	114	108	13.553	14.933
4	2	6	43.2	10.8	25	15	0.192	0.2496	0.082	0.338	117	119	12.285	13.550
5	2	2	18	3.6	5	36	0.364	0.4732	0.237	0.284	94	88	16.393	19.134
5	2	3	27	5.4	10	24	0.339	0.4368	0.230	0.284	97	92	16.304	19.006
5	2	4	36	7.2	15	18	0.289	0.3757	0.123	0.267	99	96	15.153	15.790
5	2	5	45	9	20	14	0.268	0.3484	0.079	0.334	121	112	14.126	14.752
5	2	6	54	10.8	25	12	0.231	0.3003	0.019	0.310	124	118	13.914	13.449

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
6	2	2	21.6	3.6	5	30	0.383	0.4979	0.492	0.230	74	71	16.993	18.991
6	2	3	32.4	5.4	10	20	0.321	0.4173	0.365	0.318	79	73	16.899	17.857
6	2	4	43.2	7.2	15	15	0.293	0.3809	0.277	0.332	82	86	16.848	1.784
6	2	5	54	9	20	12	0.263	0.3419	0.202	0.338	99	95	15.752	16.646
6	2	6	64.8	10.8	25	10	0.244	0.3172	0.175	0.330	133	115	12.550	14.358
7	2	2	25.2	3.6	5	25	0.376	0.4888	0.329	0.274	74	76	16.851	19.788
7	2	3	37.8	5.4	10	17	0.358	0.4654	0.273	0.279	85	79	16.798	18.712
7	2	4	50.4	7.2	15	12	0.343	0.4459	0.238	0.285	92	82	16.307	17.010
7	2	5	63	9	20	10	0.34	0.442	0.168	0.321	97	87	16.167	16.81
7	2	6	75.6	10.8	25	8	0.233	0.3029	0.149	0.334	141	144	11.831	8.331
8	2	2	28.8	3.6	5	22	0.407	0.5291	0.412	0.254	70	75	17.322	19.461
8	2	3	43.2	5.4	10	15	0.399	0.5187	0.328	0.273	74	86	16.990	18.986
8	2	4	57.6	7.2	15	11	0.363	0.4719	0.236	0.283	77	91	16.953	16.934
8	2	5	72	9	20	9	0.336	0.4368	0.215	0.294	89	98	15.853	16.790
8	2	6	86.4	10.8	25	7	0.321	0.4173	0.167	0.440	155	132	11.588	12.412
9	2	2	32.4	3.6	5	20	0.429	0.5577	0.413	0.255	72	73	17.408	19.583
9	2	3	48.6	5.4	10	13	0.388	0.5044	0.302	0.242	81	78	17.304	17.435
9	2	4	64.8	7.2	15	10	0.379	0.4927	0.208	0.249	86	79	17.016	16.024
9	2	5	81	9	20	8	0.373	0.4849	0.145	0.414	92	88	16.844	15.778
9	2	6	97.2	10.8	25	6	0.326	0.4238	0.075	0.254	190	149	13.617	11.453

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
10	2	2	36	3.6	5	18	0.421	0.5473	0.496	0.235	77	70	17.501	18.717
10	2	3	54	5.4	10	12	0.401	0.5213	0.315	0.258	84	74	17.237	18.339
10	2	4	72	7.2	15	9	0.398	0.5174	0.216	0.259	90	89	16.942	16.918
10	2	5	90	9	*20*	7	0.366	0.4758	0.196	0.355	96	97	14.884	15.835
10	*2*	*6*	*108*	*10.8*	25	*6*	*0.329*	*0.4277*	*0.069*	*0.442*	*144*	*121*	*12.624*	*13.463*
11	2	2	39.6	3.6	5	16	0.441	0.5733	0.626	0.271	66	70	17.595	18.851
11	2	3	59.4	5.4	10	10	0.41	0.533	0.518	0.261	69	84	17.497	17.711
11	2	4	79.2	7.2	15	8	0.404	0.5252	0.441	0.289	75	88	16.985	17.979
11	2	5	99	9	*20*	6	0.39	0.507	0.251	0.301	87	91	16.908	16.869
11	*2*	*6*	*118.8*	*10.8*	25	*5*	*0.34*	*0.442*	*0.162*	*0.434*	*128*	*112*	*13.666*	*14.524*
12	2	2	43.2	3.6	5	15	0.435	0.5655	0.612	0.254	65	61	17.686	18.981
12	2	3	64.8	5.4	10	10	0.424	0.5512	0.509	0.258	69	66	17.441	17.630
12	2	4	86.4	7.2	15	7	0.403	0.5239	0.414	0.256	74	79	17.679	17.970
12	2	5	108	9	*20*	6	0.353	0.4589	0.308	0.249	85	85	16.932	16.904
12	*2*	*6*	*129.6*	*10.8*	25	*5*	*0.351*	*0.4563*	*0.166*	*0.439*	*100*	*99*	*14.702*	*15.575*
13	2	2	46.8	3.6	5	13	0.491	0.6383	0.617	0.260	62	61	18.151	17.645
13	2	3	70.2	5.4	10	9	0.475	0.6175	0.578	0.333	69	65	17.540	17.772
13	2	4	93.6	7.2	15	6	0.456	0.5928	0.476	0.331	73	71	17.487	16.696
13	2	5	117	9	*20*	5	0.396	0.5148	0.356	0.307	85	88	16.902	15.861
13	2	6	140.4	10.8	25	4	0.346	0.4498	0.274	0.448	96	95	16.689	15.557

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
14	2	2	50.4	3.6	5	12	0.499	0.6448	0.611	0.253	65	63	18.236	18.767
14	2	3	75.6	5.4	10	8	0.48	0.624	0.435	0.282	72	67	18.068	16.526
14	2	4	100.8	7.2	15	6	0.466	0.6058	0.39	0.322	77	79	17.701	16.002
14	2	5	126	9	20	5	0.452	0.5876	0.275	0.3300	84	84	17.590	15.844
14	2	6	151.2	10.8	25	4	0.444	0.5772	0.196	0.595	95	92	16.683	15.548
15	2	2	54	3.6	5	12	0.553	0.7189	0.501	0.241	60	63	18.176	19.680
15	2	3	81	5.4	10	8	0.513	0.6669	0.435	0.282	75	67	17.518	18.741
15	2	4	108	7.2	15	6	0.491	0.6383	0.369	0.322	79	77	16.968	16.955
15	2	5	135	9	20	4	0.433	0.5629	0.249	0.298	86	85	16.845	15.779
15	2	6	162	10.8	25	4	0.424	0.5512	0.208	0.369	93	94	16.647	15.496
16	2	2	57.6	3.6	5	11	0.429	0.5577	0.752	0.182	62	65	18.357	18.939
16	2	3	86.4	5.4	10	7	0.566	0.7358	0.666	0.319	65	72	17.464	16.664
16	2	4	115.2	7.2	15	5	0.546	0.7098	0.642	0.296	74	89	17.639	16.914
16	2	5	144	9	20	4	0.526	0.6838	0.371	0.325	81	91	17.518	15.740
16	2	6	172.8	10.8	25	3	0.478	0.6214	0.289	0.466	95	93	17.324	15.463
17	2	2	61.2	3.6	5	10	0.599	0.7787	0.619	0.228	60	63	18.357	19.939
17	2	3	91.8	5.4	10	7	0.562	0.7306	0.543	0.291	69	67	18.122	18.604
17	2	4	122.4	7.2	15	5	0.543	0.7059	0.467	0.320	73	72	17.616	17.88
17	2	5	153	9	20	4	0.526	0.6838	0.376	0.331	85	63	17.495	16.708
17	2	6	183.6	10.8	25	3	0.513	0.6669	0.299	0.358	92	93	15.389	16.985

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
18	2	2	64.8	3.6	5	10	0.608	0.7904	0.512	0.134	63	61	17.745	16.065
18	2	3	97.2	5.4	10	6	0.598	0.7774	0.406	0.247	68	66	17.384	16.549
18	2	4	129.6	7 2	15	5	0.589	0.7657	0.323	0 267	75	76	17.588	15.841
18	2	5	162	9	20	4	0.518	0.6743	0.213	0.255	86	89	17.478	15.683
18	2	6	194.4	10.8	25	3	0.498	0.6474	0.208	0.249	94	92	17.323	15.462
19	2	2	68.4	3.6	5	9	0.658	0.8554	0.835	0.162	62	65	18.927	17.754
19	2	3	102.6	5.4	10	6	0.603	0.7839	0.663	0.195	71	71	18.836	17.624
19	2	4	136.8	7.2	15	4	0.513	0.6669	0.609	0.202	79	74	17.742	16.06
19	2	5	171	9	20	3	0.508	0 6604	0.412	0 254	86	85	17.522	15.747
19	2	6	205.2	10.8	25	3	0.479	0 6227	0.231	0.277	92	90	17.365	15.522
20	2	2	72	3.6	5	9	0.85	1.105	0.826	0 151	60	61	18.848	17.640
20	2	3	108	5.4	10	6	0.835	1.0855	0.766	0 312	69	65	18.792	17.56
20	2	4	144	7.2	15	4	0.808	1.0504	0.678	0.336	77	70	18.411	16.017
20	2	5	180	9	20	3	0.728	0.9464	0.578	0.336	82	75	18.222	15.746
20	2	6	216	10.8	25	3	0 640	0 832	0.51	0.301	89	87	18.066	18.523
2	3	2	7.2	3.6	5	60	0.227	0.2951	0.248	0.297	52	50	12.753	19.934
2	3	3	10.8	5 4	10	40	0 224	0 2912	0.209	0 130	85	79	18.549	17.214
2	3	4	14.4	7.2	15	30	0.212	0 2756	0.162	0.094	100	101	15196	14.709
2	3	5	18	9	20	24	0.194	0.2522	0.152	0.064	122	117	12.313	13.876
2	3	6	21.6	10.8	25	20	0.183	0 2379	0 149	0.028	129	132	10 948	12.783

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/ row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
3	3	2	10.8	3.6	5	40	0.274	0.3562	0.251	0.181	63	57	18.923	16.748
3	3	3	16.2	5.4	10	62	0 216	0.2808	0.215	0.163	84	65	18.169	15.670
3	3	4	21.6	7.2	15	20	0.179	0.2327	0.162	0.144	101	102	15.464.	10.664
3	3	5	27	9	20	16	0.163	0.2119	0.154	0.088	131	114	13.538	10.769
3	3	6	32.4	10.8	25	13	0.147	0.1911	0.107	0.004	137	121	7.380	10.544
4	3	2	14.4	3.6	5	30	0.296	0.3848	0.211	0.253	56	59	18.135	17.051
4	3	3	21.6	5.4	10	20	0.281	0.3653	0.216	0.212	74	89	17.631	16.331
4	3	4	28.8	7.2	15	15	0.178	0.2314	0.155	0.186	87	92	16.891	15.702
4	3	5	36	9	20	12	0.16	0.208	0.116	0.112	102	106	15.078	11.540
4	3	6	43.2	10.8	25	10	0.12	0.156	0.112	0.107	114	118	14.983	11.405
5	3	2	18	3.6	5	24	0.238	0.3094	0.175	0.21	73	58	19.342	18.347
5	3	3	27	5.4	10	16	0.207	0.2691	0.165	0.198	85	64	18.873	17.677
5	3	4	36	7.2	15	12	0.172	0.2236	0 156	0.187	92	72	16.852	16.646
5	3	5	45	9	20	9	0.155	0.2015	0.148	0.177	124	119	15.726	12.467
5	3	6	54	10.8	25	8	0.113	0.1469	0.121	0.101	137	126	14.955	11.365
6	3	2	21.6	3.6	5	20	0 226	0.2938	0.181	0.217	52	65	19.206	16.152
6	3	3	32.4	5.4	10	13	0.214	0.2782	0.176	0.211	75	73	18.757	16.511
6	3	4	43.2	7.2	15	10	0.171	0.2223	0.161	0.093	89	95	17.825	15.608
6	3	5	54	9	20	8	0.157	0.2041	0.126	0.063	137	125	14.978	11.398
6	3	6	64.8	10.8	25	6	0 147	0.1911	0 101	0.041	140	132	14.707	11.01

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/ row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
7	3	2	25.2	3.6	5	17	0.258	0.3354	0.319	0.242	55	85	18.359	16.371
7	3	3	37.8	5.4	10	11	0.233	0.3029	0.273	0.207	68	66	18.742	15.489
7	3	4	50.4	7.2	15	8	0.206	0.2678	0.186	0.123	87	92	17.936	12.767
7	3	5	63	9	20	6	0.195	0.2535	0.152	0.118	143	130	15.780	12.543
7	3	6	75.6	10.8	25	5	0.192	0.2496	0.117	0.036	149	144	14.854	11.220
8	3	2	28.8	3.6	5	15	0.298	0.3874	0.335	0.362	61	67	17.810	18.158
8	3	3	43.2	5.4	10	10	0.283	0.3679	0.268	0.201	77	89	16.157	15.653
8	3	4	57.6	7.2	15	7	0.245	0.3185	0.212	0.154	90	92	16.250	15.787
8	3	5	72	9	20	6	0.201	0.2613	0.195	0.134	161	137	8.057	11.511
8	3	6	86.4	10.8	25	5	0.191	0.2483	0.115	0.108	169	152	7.859	11.228
9	3	2	32.4	3.6	5	13	0.286	0.3718	0.457	0.484	85	88	15.782	16.975
9	3	3	48.6	5.4	10	8	0.279	0.3627	0.396	0.335	91	89	15.602	15.289
9	3	4	64.8	7.2	15	6	0.265	0.3445	0.298	0.306	92	90	14.250	14.787
9	3	5	81	9	20	5	0.231	0.3003	0.192	0.230	175	143	8.026	11.467
9	3	6	97.2	10.8	25	4	0.192	0.2496	0.136	0.202	181	149	7.868	11.240
10	3	2	36	3.6	5	12	0.306	0.3978	0.421	0.542	83	87	9.653	13.79
10	3	3	54	5.4	10	8	0.273	0.3549	0.332	0.514	95	90	8.549	12.214
10	3	4	72	7.2	15	6	0.264	0.3432	0.308	0.3496	96	92	8.946	12.780
10	3	5	90	9	20	4	0.245	0.3185	0.206	0.247	186	151	8.026	11.467
10	3	6	108	10.8	25	4	0.231	0.2769	0.171	0.125	191	163	7.862	11.232

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
11	3	2	39.6	3.6	5	10	0.349	0.4537	0.573	0.407	81	91	9.135	13.051
11	3	3	59.4	5.4	10	7	0.294	0.3822	0.401	0.332	98	88	8.743	12.491
11	3	4	79.2	7.2	15	5	0.289	0.3757	0.334	0.280	97	98	8.978	12.827
11	*3*	*5*	*99*	*9*	*20*	*4*	*0.256*	*0.3328*	*0.218*	*0.261*	*190*	*164*	*8.104*	*11.578*
11	3	6	18.8	10.8	25	3	0.208	0.2704	0.159	0.108	199	175	7.923	11.318
12	3	2	43.2	3.6	5	10	0.419	0.5447	0.543	0.716	84	89	9.835	14.051
12	3	3	64.8	5.4	10	6	0.396	0.5148	0.485	0.622	88	91	9.443	13.491
12	3	4	86.4	7.2	15	5	0.289	0.3757	0.317	0.404	99	97	8.976	12.824
12	3	5	108	9	**20**	4	0.256	0.3328	0.181	0.172	194	160	8.804	10.578
12	*3*	*6*	*129.6*	*10.8*	*25*	*3*	*0.256*	*0.3328*	*0.127*	*0.124*	*197*	*173*	*8.638*	*10.340*
13	3	2	46.8	3.6	5	9	0.437	0.5681	0.588	0.616	82	94	10.06	14.377
13	3	3	70.2	5.4	10	6	0.405	0.5265	0.437	0.544	99	99	9.439	13.485
13	3	4	93.6	7.2	15	4	0.389	0.5057	0.375	0.333	94	88	8.976	12.824
13	*3*	*5*	*117*	*9*	*20*	*3*	*0.297*	*0.3861*	*0.252*	*0.224*	*162*	*169*	*8.762*	*12.518*
13	3	6	140.4	10.8	25	3	0.261	0.3393	0.223	0.176	174	149	8.629	12.328
14	3	2	50.4	3.6	5	8	0.441	0.5733	0.618	0.6416	81	89	10.11	14.456
14	3	3	75.6	5.4	10	5	0.405	0.5265	0.514	0.568	95	97	9.439	13.485
14	3	4	100.8	7.2	15	4	0.39	0.507	0.528	0.336	99	99	8.983	12.834
14	*3*	*5*	*126*	*9*	*20*	*3*	*0.377*	*0.4901*	*0.386*	*0.322*	*141*	*139*	*8.762*	*12.518*
14	3	6	151.2	10.8	25	2	0.258	0.3354	0.211	0.232	153	146	8.629	12.328

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
15	3	2	54	3 6	5	8	0 54	0.702	0.678	0.736	87	83	10.12	14 458
15	3	3	81	5 4	10	5	0.498	0.6474	0.598	0.676	89	89	8.791	12.559
15	3	4	108	7.2	15	4	0 458	0.5954	0.485	0 442	95	94	8.953	12.791
15	3	5	135	9	20	3	0.397	0.5161	0.362	0.314	130	122	8.762	12.518
15	3	6	162	10.8	25	2	0.306	0.3978	0.249	0.298	135	124	8.606	12.295
16	3	2	57.6	3.6	5	7	0.564	0.7332	0.745	0.742	80	79	10.07	14.389
16	3	3	86.4	5.4	10	5	0 544	0.7072	0.672	0.654	84	87	8.761	12.516
16	3	4	115.2	7.2	15	3	0.483	0.6279	0 427	0.422	89	92	8.938	12.769
16	3	5	144	9	***20***	3	0.394	0.5122	0.375	0.333	91	97	8.749	12.499
16	3	6	172.8	10 8	25	2	0.325	0 4225	0.286	0.312	112	102	8.584	12.263
17	3	2	61.2	3.6	5	7	0 642	0 8346	0 768	0.716	87	81	10.15	14.512
17	3	3	91.8	5.4	10	4	0.593	0.7709	0.682	0 614	94	92	9.446	13.495
17	3	4	122.4	7.2	15	3	0.508	0.6604	0.574	0.588	55	94	8.219	11.742
17	3	5	153	9	***20***	2	0 499	0.6487	0 379	0.448	94	96	8.031	11.474
17	3	6	183.6	10 8	25	2	0 454	0.5902	0.217	0.234	100	99	7.877	11.254
18	3	2	64.8	3.6	5	6	0 739	0.9607	0.711	0.732	82	82	10.12	14.459
18	3	3	97.2	5 4	10	4	0 689	0.8957	0.682	0.684	88	89	8.078	12.440
18	3	4	129.6	7 2	15	3	0 678	0.8814	0.593	0.516	91	94	8.904	12.721
18	3	5	162	9	***20***	2	0 594	0.7722	0.318	0 402	99	95	8.752	12.503
18	3	6	194.4	10 8	25	2	0 447	0.5811	0.271	0.325	100	98	8.629	12.328

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m²	Plot size m²	Sample size (plants/row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
19	3	2	68.4	3.6	5	6	0.752	0.9776	0.715	0.838	83	82	10.26	14.663
19	3	3	102.6	5.1	10	4	0.694	0.9022	0.684	0.708	89	94	9.478	13.540
19	3	4	136.8	7.2	15	3	0.663	0.8619	0.493	0.626	95	91	8.996	12.852
19	3	5	171	9	***20***	2	0.606	0.7878	0.321	0.452	97	95	8.780	12.544
19	3	6	205.2	10.8	25	2	0.518	0.6734	0.251	0.301	98	96	8.656	12.366
20	3	2	72	3.6	5	6	0.855	1.1115	0.817	0.804	92	91	10.29	14.710
20	3	3	108	5.4	10	4	0.796	1.0348	0.548	0.776	95	98	9.468	13.527
20	3	4	144	7.2	15	3	0.782	1.0166	0.386	0.692	96	99	9.066	12.952
20	3	5	180	9	***20***	2	0.622	0.8086	0.281	0.472	102	99	8.794	12.564
20	3	6	216	10.8	25	2	0.608	0.7904	0.107	0.244	95	100	8.672	12.389
2	4	2	7.2	3.6	5	45	0.267	0.3471	0.269	0.822	103	101	7.961	10.23
2	4	3	10.8	5.4	10	30	0.450	0.3185	0.512	0.744	100	99	10.74	15.35
2	4	4	14.4	7.2	15	22	0.321	0.273	0.427	0.524	109	102	10.45	14.94
2	4	5	18	9	***20***	18	0.295	0.2535	0.242	0.404	115	107	9.107	13.01
2	4	6	21.6	10.8	25	15	0.185	0405	0.202	0.312	122	110	9.38	13.4
3	4	2	10.8	3.6	5	30	0.418	0.4654	0.580	0.513	92	84	11.00	15.72
3	4	3	16.2	5.4	10	20	0.403	0.3939	0.480	0.401	98	100	10.19	14.57
3	4	4	21.6	7.2	15	15	0.389	0.3757	0.384	0.220	111	105	10.37	14.82
3	4	5	27	9	***20***	12	0.225	0.325	0.272	0.206	126	119	9.8	14.00
3	4	6	32.4	10.8	25	10	0.199	0.187	0.155	0.546	130	122	9.492	13.56

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/ row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
4	4	2	14.4	3.6	5	22	0.569	0.3497	0.408	0.596	68	87	10.56	15.09
4	*4*	*3*	*21.6*	*5.4*	10	*15*	*0.508*	*0.364*	*0.324*	*0.488*	*100*	*99*	*10.01*	*14.30*
4	4	4	28.8	7.2	15	11	0.476	0.3588	0.289	0.264	113	107	9.576	13.68
4	4	5	36	9	***20***	9	0.343	0.3159	0.276	0.212	120	113	9.821	14.03
4	4	6	43.2	10.8	25	7	0.212	0.356	0.195	0.194	125	119	9.15	14.51
5	4	2	18	3.6	5	18	0.684	0.4992	0.335	0.516	93	78	11.17	15.97
5	4	3	27	5.4	10	12	0.561	0.4693	0.201	0.412	98	89	10.92	15.61
5	*4*	*4*	*36*	*7.2*	15	*9*	*0.371*	*0.3523*	*0.176*	*0.312*	*116*	*99*	***10.95***	***15.649***
5	4	5	45	9	***20***	7	0.225	0.325	0.165	0.218	127	112	10.29	14.70
5	4	6	54	10.8	25	6	0.127	0.2951	0.102	0.124	134	129	10.02	14.32
6	4	2	21.6	3.6	5	15	0.726	0.5538	0.477	0.524	59	67	11.34	16.20
6	4	3	32.4	5.4	10	10	0.709	0.5317	0.396	0.352	72	78	10.82	15.46
6	*4*	*4*	*43.2*	*7.2*	15	*7*	*0.637*	*0.481*	***0.283***	***0.296***	*129*	*111*	***10.94***	***15.63***
6	4	5	54	9	***20***	6	0.455	0.4615	0.177	0.224	131	125	10.78	15.40
6	4	6	64.8	10.8	25	5	0.326	0.238	0.166	0.192	136	129	10.43	14.90
7	4	2	25.2	3.6	5	12	0.895	0.6435	0.469	0.628	54	69	11.45	16.37
7	4	3	37.8	5.4	10	8	0.891	0.6357	0.316	0.599	66	78	11.51	16.45
7	4	4	50.4	7.2	15	6	0.585	0.5005	0.292	0.404	140	128	11.04	15.78
7	4	5	63	9	***20***	5	0.366	0.4758	0.243	0.416	146	132	10.87	15.53
7	4	6	75.6	10.8	25	4	0.223	0.2899	0.175	0.333	157	139	10.73	15.33

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/ row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
8	4	2	28.8	3.6	5	11	0.828	0.6864	0.465	0.698	69	63	11.36	16.24
8	4	3	43.2	5.4	10	7	0.786	0.6318	0.356	0.552	72	78	11.52	16.47
8	4	4	57.6	7.2	15	5	0.646	0.598	0.286	0.432	160	141	11.08	15.84
8	4	5	72	9	***20***	4	0.412	0.5356	0.274	0.388	165	145	10.57	15.36
8	4	6	86.4	10.8	25	3	0.385	0.5005	0.167	0.204	169	148	10.53	15.05
9	4	2	32.4	3.6	5	10	0.562	0.7306	0.467	0.504	69	55	11.24	16.06
9	4	3	48.6	5.4	10	6	0.548	0.624	0.378	0.436	80	74	10.72	15.32
9	4	4	64.8	7.2	15	5	0.472	0.6136	0.271	0.352	167	151	11.10	15.86
9	4	5	81	9	***20***	4	0.432	0.5616	0.286	0.232	173	157	10.78	15.41
9	4	6	97.2	10.8	25	3	0.399	0.5187	0.212	0.144	175	160	10.90	15.58
10	4	2	36	3.6	5	9	0.607	0.7891	0.515	0.538	59	58	11.81	16.88
10	4	3	54	5.4	10	6	0.576	0.7488	0.435	0.462	89	77	11.38	16.26
10	4	4	72	7.2	15	4	0.489	0.6357	0.302	0.424	179	162	11.08	15.84
10	4	5	90	9	***20***	3	0.46	0.598	0.266	0.392	183	165	10.66	15.23
10	4	6	108	10.8	25	3	0.433	0.529	0.189	0.268	187	179	11.13	15.90
11	4	2	39.6	3.6	5	8	0.622	0.8086	0.539	0.668	62	71	12.01	17.17
11	4	3	59.4	5.4	10	5	0.594	0.7722	0.489	0.568	81	87	11.55	16.50
11	4	4	79.2	7.2	15	4	0.593	0.7709	0.311	0.432	182	177	11.10	15.86
11	4	5	99	9	***20***	3	0.552	0.7176	0.271	0.352	184	181	10.72	15.32
11	4	6	118.8	10.8	25	2	0.474	0.6162	0.268	0.216	189	186	10.50	15.01

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/ row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
12	4	2	43.2	3.6	5	7	0.634	0.8242	0.568	0.616	59	56	12.16	17..38
12	4	3	64.8	5.4	10	5	0.609	0.7917	0.481	0.572	77	75	11.59	16..57
12	4	4	86.4	7.2	15	3	0.593	0.7709	0.324	0.488	94	89	11.10	15.87
12	4	5	108	9	20	3	0.576	0.7488	0.235	0.282	193	180	10.88	15.54
12	4	6	129.6	10.8	25	2	0.519	0.6747	0.155	0.106	202	187	10.73	15.34
13	4	2	46.8	3.6	5	6	0.648	0.8424	0.528	0.536	64	54	12.26	17.52
13	4	3	70.2	5.4	10	4	0.606	0.7878	0.481	0.477	75	68	12.35	17.65
13	4	4	93.6	7.2	15	3	0.592	0.7696	0.386	0.323	89	74	11.10	15.86
13	4	5	117	9	20	2	0.564	0.7332	0.213	0.255	201	185	10.90	15.58
13	4	6	140.4	10.8	25	2	0.495	0.6435	0.122	0.127	204	189	10.82	15.47
14	4	2	50.4	3.6	5	6	0.745	0.9685	0.612	0.644	50	53	11.59	16..56
14	4	3	75.6	5.4	10	4	0.71	0.923	0.528	0.536	72	62	11.69	16.71
14	4	4	100.8	7.2	15	3	0.694	0.9022	0.556	0.472	84	81	11.11	15.883
14	4	5	126	9	20	2	0.653	0.8489	0.377	0.324	210	196	10.68	15.26
14	4	6	151.2	10.8	25	2	0.589	0.7657	0.298	0.276	211	202	10.58	15.12
15	4	2	54	3.6	5	6	0.76	0.988	0.605	0.626	51	43	12.24	17.49
15	4	3	81	5.4	10	4	0.733	0.952	0.523	0.476	63	65	12.39	17.71
15	4	4	108	7.2	15	3	0.689	0.8957	0.442	0.404	222	199	11.78	12.84
15	4	5	135	9	20	2	0.622	0.808	0.249	0.388	224	204	11.30	8.15
15	4	6	162	10.8	25	2	0.589	0.765	0.161	0.232	115	108	10.59	8.14
16	4	2	57.6	3.6	5	5	0.837	1.088	0.703	0.536	49	45	12.18	7.41
16	4	3	86.4	5.4	10	3	0.799	1.038	0.609	0.408	60	56	12.30	7.58

Table 3: cont.

No. of Plots (k)	No. of blocks (b)	No. of Samples (S)	Block size (b) m^2	Plot size m^2	Sample size (plants/ row)	No. of Exp.	Experimental error (E)		Sampling Error (SE)		Relative efficiency (RE) %		Coefficient of Variations (C.V.) %	
							Season1	Season2	Season1	Season2	Season1	Season2	Season1	Season2
16	4	4	115.2	7.2	15	2	0.787	1.023	0.426	0.312	73	67	8.76	6.81
16	4	5	144	9	20	2	0.738	0.959	0.234	0.208	230	217	7.22	6.04
16	4	6	172.8	10.8	25	1	0.686	0.891	0.214	0.168	209	**207**	7.71	5.3
17	4	2	61.2	3.6	5	5	0.858	1.115	0.604	0.648	68	60	11.52	16..47
17	4	3	91.8	5.4	10	3	0.799	1.038	0.517	0.404	77	79	11.55	16.50
17	4	4	122.4	7.2	15	2	0.785	1.020	0.425	0.315	87	88	11.05	15.79
17	4	5	153	9	20	2	0.757	0.984	0.236	0.1302	214	197	8.85	12.51
17	4	6	183.6	10.8	25	1	0.696	0.904	0.147	0.164	185	209	9.74	11.35
18	4	2	64.8	3.6	5	5	0.938	1.219	0.601	0.712	57	60	12.25	17.45
18	4	3	97.2	5.4	10	3	0.896	1.164	0.525	0.615	72	74	12.27	17.53
18	4	4	129.6	7.2	15	2	0.884	1.149	0.438	0.556	85	82	11.75	16.79
18	4	5	162	9	20	2	0.796	1.034	0.342	0.404	162	135	11.34	10.21
18	4	6	194.4	10.8	25	1	0.756	0.982	0.248	0.276	166	137	8.51	9.02
19	4	2	68.4	3.6	5	4	0.946	1.229	0.582	0.984	79	74	12.31	17.59
19	4	3	102.6	5.4	10	3	0.899	1.168	0.501	0.920	81	85	11.59	16.57
19	4	4	136.8	7.2	15	2	0.797	1.036	0.498	0.761	89	91	11.84	16.92
19	4	5	171	9	20	1	0.758	0.985	0.311	0.332	141	114	10.88	15.55
19	4	6	205.2	10.8	25	1	0.712	0.925	0.123	0.276	140	117	10.78	15.41
20	4	2	72	3.6	5	4	1.35	1.755	0.511	0.932	58	67	13.02	18.61
20	4	3	108	5.4	10	3	1.2	1.560	0.413	0.856	70	79	12.28	17.556
20	4	4	144	7.2	15	2	0.891	1.158	0.370	0.704	78	87	11.83	16.90
20	4	5	180	9	**20**	1	0.856	1.112	0.219	0.428	91	95	11.59	16.57
20	4	6	216	10.8	25	1	0.808	1.050	0.162	0.332	100	102	11.27	16.11

Coefficient of variation (C.V.) also used as indicator for precision of experiment as shown in Table 3. The estimates of coefficient of variation for previous optimum combinations of 2, 3 and 4 blocks were 13.62, 8.64 and 7.22 % in the first season and 11.45, 10.34 and 6.04 % in the second one, respectively. These results indicated that increasing number of blocks increased precision of the experiment and gain of the analysis. Also, results showed that increasing number of blocks reduced size of sample at the same precision and same gain of the analysis .

Experimental (E) and sampling (S) errors also compared with each other to estimate the optimum sample size. When, sampling error values started to be less than or equal to experimental error values meaning that experimental error is valid error and differences between samples were not significant. This measure also used as indicator to choose the optimum previous combinations. Table 3 clears that sampling error scored 0.075, 0.127 and 0.234 in the first season and 0.254, 0.124 and 0.208 in the second season compared with 0.326, 0.256 and 0.738 in the first season and 0.424, 0.333 and 0.959 for experimental error in the second season for 2,3 and 4 blocks, respectively.

Generally Table 3 shows that changing number of samples (s) as well as plot size and making number of plots (k) and blocks (b) constant the researcher can determine his optimum combinations depending upon variability of his variables, the nature of his treatments and thier costs depending upon maximum value of relative efficiency (RE) and minimum value of coefficient of variation (C.V) in the two seasons. Also, these estimates indicate that the homogeneity started to be clear in plots and blocks and we can consider these measures as tools in homogeneity trials.
Previous results are similar to those obtained by Charles and Mason (1959), Rampton and Petersen (1962), Torrie *et.al.* (1963) and Wei Wei *et.al.* (2001) for number of replications, Torrie *et.al.* (1963) for number of blocks and plot size. Galal and Abou El-Fittouh (1971), Khalil *et.al.* (1971) , El-Kalla and Gomaa (1977), EL- Rassas (1982), EL- Rayes *et.al.* (1993) and Ashmawy *et.al.* (2003) for plot size. Abou-El-Fittouh (1976) for relative efficiency in randomized complete blocks design. Lin and Binns (1986) for relative efficiency of randomized blocks design with different plot size and number of plots per block. Cochran (1977), Casler and Ehike (1985), Lefoet (1987), Nasr (1991), Surin (1992) and Zedaker, *et.al.* (1993) for optimum sample size. EL- Taweel (2004) for number of plots, blocks, sample as well as their sizes in randomized complete blocks design.

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دراسة تأثير العلاقة المتداخلة بين عدد القطع والقطاعات والعينات وأحجامها على كفاءة ودقة التجارب في الذرة الرفيعة

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**قسم الذرة الرفيعة– معهد بحوث المحاصيل الحقلية– مركز البحوث الزراعية – الجيزة

يؤثر تجانس التربة في النتائج الخاصة بالتجارب ويمكن تقليل ذلك التاثير عن طريق استخدام التصميم الملائم وكذلك المساحة المناسبة للقطعة والقطاع وعدد المكررات والعينات المناسب لكل تجربة. وقد أجريت هذه الدراسة لاستخلاص العلاقة المتداخلة بين العوامل السابقة معايرة بالخطا التجريبي وخطا العينة والكفاءة النسبية ومعامل الاختلاف كمقاييس للدقة لتصميم القطاعات الكاملة العشوائية في تجارب الذرة الرفيعة. وقد أقيمت تجربتي تجانس في محطة بحوث شندويل بمحافظة سوهاج خلال موسمي ٢٠٠٤ وكذلك ٢٠٠٥ على الصنف دورادو وقد طبقت كل المعاملات الزراعية الموصى بها في تلك التجارب. وكانت مساحة الحقل التجريبي ٢٢٨٧,٥ متر مربع (٠,٥٤٥ فدان) قسمت إلى ٦ شرائح بكل شريحة ١٢٠ خط كوحدات أساسية. وقد تمت الزراعة يومي ١٠ ، ١٩ يونيو وتم الحصاد في ١٠ ، ١٩ اكتوبر من عامي ٢٠٠٤ وكذلك ٢٠٠٥ على الترتيب و تم حصاد كل خط على حدة بعد استبعاد نباتين من كلا طرفى الخط لاستبعاد تاثير النطاق وكان حجم العينات المستخدمة هو ٥ ، ١٠ ، ١٥ ، ٢٠ ، ٢٥ نبات و تم استخدام تصميم القطاعات الكاملة العشوائية لتحليل البيانات مع تغيير عدد القطع (k) وعدد المكررات (b) وعدد العينات (s) وكذلك المساحات المختلفة للقطع والقطاعات والعينات خلال الموسمين.

وقد أشارت النتائج إلى أن التوليفة المثلى مع ٢ ، ٣ ، ٤ مكررات بمساحة ٩٧,٢ ، ١٢٩,٦ ، ١٤٤ متر مربع مساحة للقطاع مع ٩ ، ١٢ ، ١٦ قطعة تجريبية بكل قطاع بمساحة ١٠,٨ ، ١٠,٨ ، ٩ متر مربع لكل قطعة ومع عينات مكونة من ٢٥ ، ٢٥ ٢٠ نبات وقد سجلت هذه التوليفة السابقة كفاءة نسبية ١٩٠ ، ١٩٧ ، ٢٣٠ % فى الموسم الاول وكذلك ١٤٩ ، ١٧٣ ، ٢١٧ % فى الموسم الثانى على التوالى. وقد سجلت قيم معامل الاختلاف ١٣,٦٢ ، ٨,٦٤ ، ٧,٢٢ % فى الموسم الاول كما سجلت ١١,٤٥ ، ١٠,٣٤ ، ٦,٠٤ % فى الموسم الثانى على التوالى هذه النتائج ايضا اوضحت ان زيادة عدد المكررات يمكن معه تقليل حجم العينة مع الحفاظ على ثبات دقة التجربة وكفاءة التحليل اما بالنسبة لقيم خطأ العينة والخطأ التجريبى فتم مقارنتها واوضحت النتائج ان قيم خطا العينة سجلت ٠,٠٧٥ ، ٠,١٢٧ ، ٠,٢٣٤ فى الموسم الاول وسجلت ٠,٢٥٤ ، ٠,١٢٤ ، ٠,٢٠٨ فى الموسم الثانى مقارنة بقيم الخطا التجريبى التى سجلت ٠,٣٢٦ ، ٠,٢٥٦ ، ٠,٧٣٨ فى الموسم الاول ، ٠,٤٢٤ ، ٠,٣٣٣ ، ٠,٩٥٩ فى الموسم الثانى على الترتيب.

وقد تبين من النتائج أن زيادة مساحة القطاع مع زيادة عدد القطاعات معا يزيد من الكفاءة النسبية للتجربة وان زيادة عدد القطع التجريبية بالقطاع مع زيادة عدد المكررات وحجم العينة معا يؤدى جملة إلى زيادة دقة التجربة وكفاءة التحليل.