

## RESULTS AND DISCUSSION

## IV. RESULTS AND DISCUSSION

### A. Uniformity trials.

Two uniformity trials were conducted in each of 1998/99 and 1999/2000 winter growing seasons with two lentil varieties Giza 4 and Giza 51 to study soil heterogeneity index, optimum plot size and shape.

The original data of seed yield (g) for each basic unit (1.0 m long x 0.3 m width = 0.3 m<sup>2</sup>) in six strips at Sids research station are presented in Tables (4-7), where Tables (4 and 5) represent the data of Giza 4 in 1998 - 99 and 1999/2000, respectively, and Tables (6 and 7) showed the data of Giza 51 in the same seasons, respectively. The obtained data showed that the total seed yield per basic unit of Giza 4 in 1998/99 ranged from 0.9 to 33.8 g with an average of 9.51 g (Table 4), while in 1999/2000 the range of seed yield for Giza 4 was from 0.8 g to 18.4 g with an average of 6.51 g/basic unit (Table 5). For the other variety Giza 51, its seed yield ranged from 0.9 g to 26.6 g /basic unit, with an average of 8.26 g in the first season (Table 6), while in the second season the range of its seed yield was 0.5-17.2 g with an average of 5.87 g / basic unit (Table 7).

These data indicated that both varieties showed wide range of seed yield per basic unit. The data indicated also that the average seed yield, as well as its range were higher in the first season than in the second one for both varieties, which reflect the variation in weather conditions in both seasons at Sids research station as shown in Table (3). These data indicated that the plasticity of lentil is very high, which means that lentil plants are highly influenced by environmental conditions, such as soil

Table (4). Lentil yield (g) for each basic unit (one row) in six strips in the uniformity trial of the variety Giza 4 at Sids research station in 1998-1999 season.

Strips						
Row number	1	2	3	4	5	6
1	8.7	6.8	10.9	7.3	4.6	12.3
2	0.9	8.8	10.0	7.7	9.2	6.9
3	9.1	5.8	8.2	7.7	6.7	9.3
4	12.8	13.2	2.7	7.9	12.5	7.6
5	6.9	10.6	10.2	5.9	10.3	8.4
6	13.2	8.8	13.9	11.6	3.8	10.3
7	20.5	7.9	14.4	9.8	6.6	7.7
8	7.1	3.7	6.4	5.1	8.4	5.9
9	13.3	6.9	8.6	1.8	7.6	7.2
10	13.4	11.5	7.2	12.8	3.6	2.4
11	4.6	14.1	17.0	6.0	3.8	8.7
12	11.1	7.1	18.1	15.1	4.1	9.6
13	10.8	11.8	4.2	7.9	8.3	12.5
14	6.0	10.8	9.2	3.4	5.1	5.8
15	9.4	8.1	17.0	8.3	6.3	6.1
16	5.1	14.1	5.6	10.6	3.7	8.6
17	8.7	5.8	19.2	8.6	4.6	4.1
18	19.5	5.8	10.4	13.7	4.0	12.0
19	24.4	8.0	19.5	13.8	8.5	10.7
20	9.7	8.0	8.4	8.2	11.6	3.6
21	16.3	3.3	6.5	5.2	5.8	6.9
22	13.0	9.2	4.2	5.8	9.8	9.7
23	9.9	8.3	11.2	4.8	16.0	6.2
24	8.0	7.1	3.8	10.3	5.5	8.1
25	16.5	5.4	17.0	6.1	3.8	8.6
26	4.6	7.4	2.8	9.0	9.6	6.5
27	14.7	12.7	17.4	3.7	13.0	14.3
28	14.6	8.9	9.5	4.8	9.0	9.5
29	9.8	3.9	4.7	9.8	8.7	10.4
30	10.4	8.0	4.4	3.6	6.7	5.8

Table (4). Cont'd.

Strips						
Row number	1	2	3	4	5	6
31	8.1	7.7	22.1	11.8	5.8	8.1
32	9.0	8.6	9.3	7.6	2.6	6.4
33	5.6	9.1	6.0	8.0	5.7	11.5
34	5.8	4.6	8.2	4.1	15.0	8.0
35	9.2	4.7	14.6	10.1	12.7	14.2
36	7.4	4.3	9.5	11.7	18.0	6.1
37	11.9	7.7	8.5	9.7	16.8	16.0
38	2.6	12.2	2.5	6.3	11.5	11.1
39	11.4	7.2	17.4	20.1	15.2	9.5
40	11.7	4.10	12.3	14.5	10.3	8.8
41	15.1	5.6	6.7	10.9	21.2	5.1
42	2.5	6.6	2.0	9.1	9.3	5.0
43	8.7	7.5	5.6	8.4	5.2	9.7
44	7.2	5.7	9.3	5.9	14.2	9.0
45	10.7	9.5	16.9	4.5	8.7	10.1
46	6.7	9.3	7.7	8.2	3.6	6.5
47	7.2	16.7	11.3	6.5	10.0	9.9
48	10.6	8.6	7.6	12.3	11.1	7.8
49	11.3	12.0	33.8	11.9	10.2	12.4
50	10.6	3.6	2.5	5.4	10.9	9.4
51	11.6	9.3	13.9	9.6	14.1	3.8
52	13.2	8.5	13.4	1.2	10.6	5.2
53	11.6	8.0	4.6	8.6	8.6	9.1
54	6.3	5.6	12.8	10.8	7.7	6.1
55	8.5	6.7	10.6	12.6	15.4	8.9
56	7.4	4.3	7.1	15.2	10.4	10.0
57	16.8	4.1	7.7	12.3	24.5	5.4
58	6.7	19.2	9.4	5.5	2.4	4.9
59	12.1	2.8	7.5	11.8	32.0	3.1
60	13.1	3.3	8.8	11.5	11.7	12.0

Table (4).Cont'd.

Strips						
Row number	1	2	3	4	5	6
61	13.5	21.4	11.8	12.9	6.9	6.3
62	14.1	2.9	8.6	9.4	7.1	6.9
63	13.8	4.8	9.7	11.2	7.4	5.7
64	17.1	4.4	9.2	14.8	17.5	4.7
65	13.9	3.8	28.4	4.0	20.1	6.7
66	11.6	11.1	15.9	7.3	6.8	4.4
67	12.4	14.3	10.9	11.6	9.5	3.1
68	17.6	8.5	19.8	4.9	5.1	9.7
69	4.7	4.7	2.9	29.8	10.9	4.8
70	16.0	6.5	6.3	7.7	10.3	6.1
71	9.1	8.4	6.0	12.6	10.8	7.9
72	7.8	9.3	6.1	5.2	9.1	3.2
73	11.2	10.8	7.8	18.1	12.5	7.3
74	14.9	10.4	3.7	8.7	9.3	6.3
75	7.8	9.0	7.9	9.2	8.0	7.3
76	4.9	5.5	4.8	6.3	4.9	4.5
77	9.6	8.5	22.9	4.7	13.0	10.9
78	12.2	16.8	7.0	9.9	3.9	4.8
79	16.7	3.7	10.7	6.2	19.5	16.0
80	16.4	5.6	14.7	15.3	6.3	12.9
81	16.1	5.7	16.8	8.7	10.4	10.0
82	12.7	9.5	12.1	11.4	4.2	16.8
83	10.3	14.3	12.8	5.9	14.5	6.3
84	12.1	6.4	12.6	8.4	3.2	8.2
85	19.3	8.9	7.5	13.1	7.4	9.8
86	14.9	9.4	15.0	14.4	14.7	3.6
87	14.5	7.1	18.3	13.4	13.9	14.1
88	11.9	6.1	9.1	5.9	13.2	10.4
89	13.9	16.0	4.2	7.6	7.3	12.0
90	12.9	4.2	15.6	12.4	7.9	7.5

Table (4).Cont'd.

Strips						
Row number	1	2	3	4	5	6
91	6.5	9.1	8.7	10.9	19.2	8.6
92	8.5	4.5	14.1	10.1	7.8	7.8
93	14.4	4.4	8.9	7.1	19.0	12.3
94	10.2	5.6	11.8	9.5	9.2	8.5
95	7.8	5.8	8.4	10.2	17.1	12.5
96	12.0	11.3	9.9	5.8	9.3	6.4
97	6.4	12.0	9.8	12.3	19.3	11.5
98	7.3	5.6	31.8	14.4	14.9	12.8
99	10.9	5.3	6.7	10.7	13.7	9.1
100	7.9	3.1	14.0	7.6	12.1	6.7
101	6.1	4.1	9.7	10.2	9.7	4.1
102	4.6	2.3	4.3	11.5	8.9	8.6
103	11.7	3.8	5.7	7.4	10.1	8.7
104	20.1	4.7	5.7	6.4	12.6	5.0
105	10.8	7.7	2.9	8.0	10.9	9.1
106	12.2	5.4	9.0	7.2	5.1	6.4
107	11.6	7.4	3.3	7.5	15.8	4.6
108	12.2	6.2	7.8	5.2	10.3	11.2
109	12.8	8.0	5.8	13.8	10.4	4.5
110	11.3	3.9	6.7	12.0	8.9	8.5
111	10.4	5.6	10.6	13.8	12.6	12.5
112	10.0	8.3	7.1	7.9	15.6	6.7
113	9.6	16.2	3.6	12.0	8.9	8.6
114	15.1	8.2	8.2	11.0	3.3	8.5
115	16.0	11.7	4.1	8.5	20.7	13.8
116	15.1	5.6	11.5	8.7	4.5	7.8
117	9.9	6.2	13.6	13.6	19.4	6.2
118	7.9	1.5	32.6	7.4	10.5	4.8
119	14.0	11.0	10.9	8.7	8.8	10.4
120	5.6	2.7	10.4	8.9	9.3	10.5

Table (5). Lentil yield (g) for each basic unit (one row) in six strips in the uniformity trial of the variety Giza 4 at Sids research station in 1999-2000 season.

Strips						
Row number	1	2	3	4	5	6
1	12.3	9.6	9.6	11.4	14.4	7.1
2	12.0	7.3	10.7	12.2	4.4	9.2
3	5.5	9.6	8.7	4.4	1.6	5.1
4	9.3	12.0	15.0	5.1	13.3	6.9
5	16.6	11.5	8.1	3.4	0.9	8.1
6	4.3	5.4	9.3	9.6	8.5	10.4
7	5.3	6.9	7.0	6.4	2.4	5.4
8	3.2	12.9	14.0	5.6	13.4	14.8
9	6.5	3.2	3.8	5.6	3.7	6.6
10	7.5	6.9	13.6	2.2	7.3	10.1
11	5.7	6.1	6.5	6.3	3.8	14.9
12	8.3	6.9	9.7	6.7	1.2	8.3
13	5.4	13.1	9.8	2.3	3.5	8.4
14	7.6	9.6	10.4	6.9	4.8	6.8
15	3.7	2.5	12.1	5.4	7.7	6.3
16	4.7	11.6	10.2	8.3	8.2	9.3
17	4.8	1.6	7.6	3.4	6.5	6.8
18	9.7	3.4	7.9	6.3	2.0	8.2
19	1.8	4.1	7.1	9.1	4.7	6.1
20	8.5	2.3	7.4	9.5	11.4	8.4
21	9.3	9.2	2.6	5.3	12.1	7.8
22	3.3	6.3	13.6	3.3	6.0	4.6
23	4.4	4.8	10.2	9.9	6.7	3.2
24	8.1	8.4	10.4	10.0	9.3	5.2
25	5.5	9.9	5.3	2.5	7.8	3.9
26	8.3	10.1	10.1	8.5	9.8	7.9
27	10.0	5.4	9.6	6.6	19.4	6.2
28	12.6	6.4	5.5	4.4	5.8	6.1
29	2.8	5.7	5.3	4.8	11.9	6.1
30	11.8	17.0	9.0	6.9	10.5	10.4

Table (5).Cont'd.

Strips						
Row number	1	2	3	4	5	6
91	2.4	5.7	6.5	2.9	8.6	5.1
92	3.6	8.5	7.0	4.7	8.5	4.7
93	3.3	6.9	7.3	3.6	6.1	4.3
94	4.2	11.1	4.2	3.9	6.0	7.3
95	4.0	11.8	7.2	1.8	6.4	3.8
96	4.3	3.3	5.6	3.8	6.1	2.9
97	6.8	1.6	5.1	4.8	6.6	4.3
98	4.7	6.1	11.7	7.3	6.0	5.6
99	11.4	5.3	5.9	6.3	6.2	4.1
100	6.9	3.0	12.0	1.8	6.6	6.1
101	6.7	4.6	11.3	3.0	6.8	6.3
102	4.8	4.3	4.9	5.5	8.3	9.9
103	2.3	8.0	9.4	3.3	6.4	4.2
104	9.6	4.0	4.5	5.7	9.0	4.1
105	8.4	3.6	7.2	5.0	9.5	7.4
106	3.8	7.2	11.6	4.4	7.4	4.7
107	2.3	10.1	11.1	10.2	6.7	7.3
108	4.7	6.6	7.0	4.0	5.4	2.9
109	1.0	0.8	5.3	7.7	5.3	6.3
110	3.1	4.9	6.1	6.1	5.1	3.0
111	7.8	4.7	4.4	4.0	6.4	6.8
112	9.6	5.1	11.6	3.9	4.6	4.6
113	3.2	2.7	16.2	4.8	8.2	5.2
114	6.4	5.3	6.8	3.7	11.8	3.0
115	8.3	8.7	9.8	8.2	6.9	6.9
116	4.4	6.3	3.6	5.3	6.5	4.1
117	5.4	6.8	11.4	3.9	5.2	7.6
118	1.1	4.5	13.0	5.8	13.0	4.0
119	5.5	7.0	8.4	4.5	6.6	2.9
120	5.8	6.6	3.2	12.8	9.6	2.9

Table (6). Lentil yield (g) for each basic unit (one row) in six strips in the uniformity trial of the variety Giza 51 at Sids Research Station in 1998-99 season.

Row number	Strips					
	1	2	3	4	5	6
1	3.2	8.5	4.7	4.7	7.4	6.5
2	5.3	8.7	3.8	2.1	9.3	10.5
3	4.9	4.8	5.2	7.5	7.7	6.1
4	3.1	4.5	2.1	4.1	15.0	6.4
5	8.9	4.0	7.9	6.7	3.4	4.2
6	5.9	8.6	6.6	4.5	10.0	8.8
7	3.5	5.0	6.0	7.2	4.9	4.0
8	2.4	5.3	4.7	8.0	5.0	4.8
9	6.6	13.6	12.7	9.4	13.4	6.3
10	8.9	9.6	12.1	7.0	4.4	6.5
11	7.4	3.6	9.0	12.8	7.2	8.5
12	9.4	7.0	5.5	6.0	3.9	7.2
13	9.8	17.3	14.5	12.6	6.1	7.0
14	7.1	4.8	13.7	9.0	7.4	9.8
15	8.3	9.0	16.8	8.1	3.6	10.5
16	4.8	2.6	5.0	6.4	4.5	9.4
17	2.1	2.3	7.8	6.8	6.4	9.6
18	9.8	4.1	4.0	11.3	4.6	7.5
19	2.8	2.0	9.2	8.6	12.4	11.5
20	7.4	3.4	12.8	11.2	4.1	10.1
21	6.4	7.4	23.0	26.6	9.9	5.3
22	5.5	6.7	2.1	1.4	4.3	4.1
23	4.8	6.8	9.0	9.4	8.4	9.0
24	7.2	7.2	8.3	12.8	8.5	7.6
25	5.6	13.0	5.0	1.8	6.6	4.5
26	10.5	4.3	10.6	12.3	11.7	9.5
27	10.3	12.2	11.7	6.2	11.0	7.9
28	5.6	16.0	9.4	4.6	4.4	4.2
29	15.3	9.5	11.1	16.0	6.6	11.0
30	7.5	7.5	13.5	7.0	8.4	3.2

Table (6). Cont'd

Strips						
Row number	1	2	3	4	5	6
91	4.7	22.0	3.4	9.8	9.0	10.0
92	2.0	18.1	3.9	18.3	3.6	13.5
93	12.0	12.3	10.0	2.0	10.2	16.1
94	11.8	19.9	9.1	6.2	11.1	11.7
95	12.0	14.0	13.8	6.2	12.3	9.5
96	5.5	5.6	8.4	9.0	8.6	4.1
97	5.6	8.9	17.5	4.5	8.3	14.9
98	5.4	9.0	4.4	0.9	4.1	6.2
99	7.9	7.4	8.5	2.7	5.4	7.8
100	8.8	9.1	11.2	13.7	9.9	7.2
101	3.4	11.9	9.8	14.5	9.1	10.4
102	10.7	8.1	16.8	6.6	9.9	4.5
103	6.5	9.1	5.6	8.1	8.7	11.7
104	6.1	15.8	12.7	4.7	1.8	10.1
105	4.5	9.0	25.9	7.0	9.4	6.6
106	8.6	6.3	14.2	7.4	11.0	10.6
107	2.8	4.5	6.6	8.3	3.7	6.7
108	3.8	15.2	17.6	3.6	2.6	1.4
109	2.0	9.1	13.5	5.1	11.7	11.4
110	12.3	10.8	11.5	5.6	10.6	6.0
111	3.4	10.6	15.9	12.1	4.7	13.3
112	3.2	11.8	9.0	9.3	9.2	6.9
113	6.5	13.0	7.3	11.1	6.3	16.4
114	8.0	8.7	2.5	6.0	13.5	4.5
115	3.3	9.6	4.7	12.4	3.1	5.6
116	6.6	10.1	9.9	7.0	4.1	11.3
117	15.5	11.8	7.6	13.0	8.1	6.9
118	4.8	23.2	4.6	15.2	15.7	14.0
119	4.9	6.3	10.0	9.5	6.0	15.6
120	3.8	12.6	7.1	2.0	3.1	7.8

Table (7). Lentil yield (g) for each basic unit (one row) in six strips in the uniformity trial of the variety Giza 51 at Sids research station in 1999/2000 season.

Row number	Strips					
	1	2	3	4	5	6
1	11.5	12.8	7.7	3.4	3.2	2.4
2	12.1	6.6	5.7	5.7	7.7	8.1
3	5.3	1.7	6.3	7.6	5.1	3.3
4	7.2	1.1	4.3	3.0	2.8	9.9
5	8.6	9.5	5.4	7.9	5.3	7.9
6	15.6	2.5	5.9	7.9	5.9	6.7
7	9.1	8.6	2.7	5.9	3.4	4.1
8	4.4	14.6	5.1	8.7	8.4	6.8
9	2.8	1.5	6.5	9.5	4.8	5.8
10	6.4	5.8	4.8	6.5	1.2	5.5
11	10.0	8.7	8.4	9.8	2.5	8.0
12	14.3	2.6	8.6	5.7	2.1	7.2
13	11.8	3.3	9.8	5.4	6.1	7.1
14	6.8	6.4	3.9	4.5	5.6	5.1
15	8.4	2.1	0.5	3.4	2.0	1.3
16	5.0	4.6	4.1	10.6	3.2	1.5
17	11.3	6.1	3.5	4.8	9.6	3.5
18	9.7	2.6	11.9	7.4	5.6	7.5
19	9.7	6.7	6.3	4.7	3.8	5.3
20	6.8	3.0	7.7	6.1	4.5	8.8
21	7.6	2.8	2.5	4.6	6.0	5.2
22	1.5	2.7	3.5	6.1	6.3	7.7
23	2.6	10.5	3.6	2.6	14.4	2.2
24	11.0	3.4	1.0	10.5	4.4	7.9
25	1.0	6.6	2.0	6.4	6.3	10.6
26	2.9	3.6	4.6	4.8	2.1	5.6
27	0.7	4.7	5.1	3.6	4.3	9.6
28	10.3	2.9	10.0	4.6	6.6	3.5
29	5.9	9.3	3.9	2.6	1.3	7.8
30	8.8	5.7	2.1	6.6	2.7	3.4

Table (7).: Cont'd.

Strips						
Row number	1	2	3	4	5	6
31	1.4	5.9	4.6	4.5	5.7	5.6
32	6.9	4.8	6.5	6.7	5.4	3.9
33	9.9	13.9	8.0	6.7	4.8	5.3
34	11.1	1.3	6.4	2.4	10.6	2.1
35	5.5	8.3	5.1	6.7	3.5	0.6
36	2.8	6.3	5.4	4.8	5.4	4.0
37	5.1	9.0	4.8	4.3	2.6	4.1
38	4.0	4.3	6.3	6.4	3.9	5.6
39	3.3	4.2	7.3	6.9	5.2	2.0
40	0.8	3.7	7.5	9.1	6.5	4.6
41	1.8	1.8	8.8	6.9	2.3	14.9
42	3.9	5.0	1.1	10.4	1.8	5.5
43	4.3	6.6	3.0	7.5	4.6	5.4
44	5.0	4.7	6.8	7.3	11.6	4.8
45	5.3	3.9	3.4	5.7	7.7	7.9
46	5.6	4.2	9.8	4.4	6.3	5.1
47	7.0	4.1	3.6	13.4	3.9	3.8
48	3.7	11.7	7.6	9.0	4.1	1.0
49	5.3	8.8	8.2	4.7	11.5	7.7
50	6.2	8.2	3.3	8.2	2.5	7.3
51	4.3	3.0	1.2	6.2	5.0	6.5
52	1.4	9.7	5.0	9.3	5.5	8.9
53	4.2	3.2	2.3	6.0	7.6	0.6
54	4.6	8.5	1.5	3.3	6.8	4.1
55	3.9	3.8	4.5	8.9	5.4	5.4
56	7.9	4.6	6.3	4.9	6.8	4.8
57	0.5	5.7	2.6	3.9	4.1	6.0
58	5.4	7.1	9.1	7.6	3.0	2.9
59	4.2	9.1	4.3	6.7	3.5	11.5
60	4.4	10.2	1.9	6.2	2.7	9.0

Table (7): Cont'd.

Row number	Strips					
	1	2	3	4	5	6
61	3.6	9.3	6.3	4.6	10.6	6.4
62	3.7	9.3	2.5	3.5	5.2	11.0
63	6.0	1.9	4.0	6.5	1.8	12.1
64	5.5	8.0	6.2	2.8	2.5	9.3
65	4.6	7.3	12.8	11.3	4.1	9.4
66	6.7	13.4	4.7	8.2	11.0	4.9
67	7.0	5.2	7.3	4.9	3.8	6.2
68	9.7	5.8	8.5	4.5	1.8	12.6
69	7.5	5.1	3.9	6.2	2.4	6.4
70	7.4	8.9	6.3	12.3	3.9	9.2
71	6.8	7.8	5.1	7.1	5.0	4.9
72	1.0	5.3	2.4	6.8	3.1	9.1
73	2.1	3.4	5.2	5.6	5.1	6.3
74	3.2	8.0	3.9	12.8	9.7	9.3
75	5.1	3.0	4.0	5.9	1.7	6.1
76	4.1	2.6	5.1	11.9	3.1	4.2
77	1.9	4.5	7.6	6.1	3.2	1.6
78	6.0	7.3	10.9	5.6	3.5	4.1
79	10.6	3.6	3.5	2.8	2.2	5.5
80	1.0	5.6	2.1	3.3	5.6	7.1
81	5.0	7.2	8.5	6.0	6.4	6.3
82	2.1	5.1	7.8	6.3	3.6	1.8
83	1.3	9.0	10.3	4.0	5.5	12.9
84	11.9	10.6	10.4	5.6	5.1	11.0
85	14.5	6.9	2.0	5.6	4.3	8.3
86	7.2	4.3	3.0	6.1	5.6	8.3
87	11.6	5.9	7.6	8.4	6.8	11.9
88	7.9	6.4	1.2	5.6	2.1	6.5
89	7.3	3.2	5.0	9.2	3.8	4.1
90	8.2	5.5	5.7	17.2	6.5	9.3

Table (7).: Cont'd.

Strips						
Row number	1	2	3	4	5	6
91	5.3	4.6	1.8	4.1	2.3	7.3
92	6.5	5.0	8.5	7.5	2.7	2.1
93	9.5	2.8	1.3	4.6	6.7	4.0
94	10.0	2.0	3.0	5.1	1.4	6.2
95	5.6	3.2	4.0	3.7	5.9	1.3
96	4.2	4.3	7.1	6.0	2.6	10.8
97	0.9	10.0	5.8	6.5	5.7	1.0
98	1.2	4.1	7.4	7.7	1.7	12.8
99	6.8	4.9	5.1	2.8	6.1	8.5
100	4.5	5.1	2.0	4.6	6.8	7.8
101	2.3	8.8	3.9	4.4	5.1	5.7
102	4.0	4.3	4.4	5.6	9.4	11.9
103	11.5	4.7	4.2	10.9	0.6	6.5
104	3.1	6.5	2.0	3.7	3.6	5.9
105	18.8	9.0	6.1	4.3	7.7	8.1
106	9.8	1.9	4.7	2.8	10.2	9.0
107	12.1	6.6	4.0	3.3	3.7	5.3
108	10.9	7.2	7.7	10.7	7.0	13.2
109	5.0	6.9	8.5	9.8	6.5	9.4
110	7.1	7.0	3.5	3.8	5.0	5.3
111	2.6	2.4	2.3	10.3	7.9	6.7
112	11.0	9.0	1.3	1.1	5.3	7.1
113	7.6	3.0	5.3	5.2	3.4	8.4
114	3.6	5.1	2.9	7.5	4.1	7.1
115	7.2	0.9	3.0	3.6	1.3	11.2
116	8.3	8.3	0.6	0.9	1.4	7.3
117	7.4	5.2	3.6	5.0	3.5	4.4
118	8.7	2.5	4.0	10.1	6.6	13.5
119	5.6	4.7	4.6	12.0	5.3	21.0
120	13.0	3.2	6.2	9.7	2.7	6.6

fertility and structure, soil slope and flating which affected irrigation efficiency, weather conditions and other environemntal conditions. These results are in agreement with many researchers who reported that lentil is highly influenced by environmental conditions and hence showed high plasticity (Summerfield, 1981 ; Aristarkhova and Voluzneva, 1982 ; Mohamed *et al.* 1989; Hamdi *et al.* , 1991b ; Hamdi and Rabeia, 1990 ; Hamdi *et al.*, 1992 and Selim, 2000).

#### A.1. Soil heterogeneity index.

The soil heterogeneity index (b) was estimated for each of the four trials conducted according to Smith equation . the estimates of soil heterogeneity indices were 0.8141 and 0.5662 for Giza 4 in 1998/99 and 1999/2000 seasons, respectively. While the corresponding values for Giza 51 were 0.7622 and 0.8424 for both seasons, respectively .

These estimates showed considerable differences between seasons especially for Giza 4, which reflect the importance of seasonal effects on the estimate of (b). Because we used different fields for each trial in every season, therefore the data indicates that the distribution of soil fertility varied from an experimental field to another . In addition, these results could be used to ascertain that the variations in soil variability at Sids research station farm in different years were mainly due to varying soil fertility gradients.

Out of four estimates of (b), three values were high and recorded 0.8141, 0.7622 and 0.8424, reflecting high levels of soil heterogeneity

These (b) estimates suggest that attention should be given to estimate soil variability in the determination of convenient plot size for use in lentil experiments. Similar results were also reported by Aly (1983) who found varied values of (b) in two seasons in sesame, the two values were 0.91 and 0.55 in 1981 and 1982, respectively.

Also, various estimates of (b) between seasons and locations were also reported by Abd El-Halim and Hanna (1980) in wheat, and El-Gamal *et al.* (1990) in cotton. In this regard, Koch and Rigney (1951), Charles and Mason (1959) and Weidemann and Leininger (1963) mentioned that the coefficient of soil heterogeneity (b) varied between zero (very uniform field) to one (very heterogeneous field soil in soil fertility). They added that (b) value will be constant for any given crop and any given field, but it will vary from crop to crop and from year to year as obtained in the present study.

The importance of study soil heterogeneity raised up with the fact that when adjacent plots planted simultaneously to the same variety and treated as alike as possible, will be differed in as many characters as one would care to measure quantitatively. The causes for these differences are numerous but the most obvious, and probably the most important, is soil heterogeneity.

Previous experience has shown that it is almost impossible to get an experimental site that is totally homogenous. Therefore, study the soil heterogeneity is important to determine its level before conducting experiments. Hence, that the obtained information will be a good guide to choosing a good experimental technique. Based on the premise that uniform soil

when cropped uniformly will produce a uniform crop, soil heterogeneity can be measured as the differences in performance of plants in a uniformly treated area.

## **A.2 Estimation of the optimum plot size.**

The estimated values of among plot variances, variances per basic unit, and coefficients of variability for each plot size and shape for 45 different combinations are given in Tables (8 and 9) for Giza 4 in 1998/99 and 1999/2000 seasons, respectively, and in Tables ( 10 and 11) for Giza 51 in both seasons, respectively.

The results indicated that increasing the plot size decreases the variance per basic unit and coefficient of variability. The coefficient of variability was ranged from 47.916 % for a plot size of one basic unit ( $0.3 \text{ m}^2$ ) to 4.913 % for 180 basic units ( $54 \text{ m}^2$ ) in Giza 4 variety in the first season (Table 8). While the range in the second season was from 46.539 % for one basic unit to 14.256 % for 180 basic units (Table 9) . The corresponding estimates of Giza 51 were 48.258 % for one basic unit to 8.785 % for 180 basic units in the first season ( Table 10), and from 52.003 % for one basic unit to 4.471 % for 180 basic units in the second season (Table 11).

The results showed also that increasing plot size, increased the variance among plots, whereas it reduced the variance per basic units. For example, in Giza 4 data of 1998/99 in Table (8), the variance among plots ( $V_{(x)}$ ) for one basic unit was 20.750, but when increased plot size to 180 basic units ( $V_{(x)}$ ) increased to 7068.667. In the same time the variance per basic units ( $V_x$ ) decreased from 20.750 (with one basic unit) to 0.218

Table (8). Variance and coefficient of variability of different plot sizes and shapes for 45 combinations from 720 basic units of lentil (variety Giza 4) in 1998-99 season.

Serial no.	Plot size and shape No. of basic units			Total no. of plots	Variance		Coefficient of variability CV%
	Size	rows	strip		Per basic unit $V_x$	Among plots $V_{(x)}$	
1	1	1	1	720	20.750	20.750	47.916
2	2	1	2	360	9.887	39.547	33.074
3	2	2	1	360	11.212	44.847	35.221
4	3	1	3	240	7.002	63.019	27.834
5	3	3	1	240	7.940	71.459	29.640
6	4	2	2	180	5.333	85.323	24.291
7	4	1	4	180	7.116	113.858	28.060
8	5	5	1	144	5.633	140.825	24.965
9	6	2	3	120	3.893	140.144	20.754
10	6	3	2	120	3.682	132.548	20.184
11	6	6	1	120	5.128	184.604	23.820
12	8	4	2	90	3.035	194.217	18.324
13	8	8	1	90	3.798	243.077	20.500
14	9	3	3	80	2.638	213.688	17.085
15	10	5	2	72	2.467	246.695	16.521
16	10	10	1	72	3.982	398.200	20.990
17	12	4	3	60	2.678	385.693	17.215
18	12	6	2	60	2.063	297.126	15.110
19	12	12	1	60	2.868	412.941	17.813
20	15	5	3	48	1.835	412.908	14.250
21	15	15	1	48	3.047	685.493	18.360
22	16	8	2	45	1.397	357.653	12.433
23	18	6	3	40	1.601	518.843	13.311
24	20	10	2	36	1.794	717.389	14.087
25	20	20	1	36	2.639	1055.743	17.089
26	24	8	3	30	1.209	696.535	11.567
27	24	12	2	30	0.951	547.716	10.257
28	24	24	1	30	2.426	1397.155	16.382
29	30	10	3	24	1.308	1177.424	12.031
30	30	15	2	24	1.095	985.065	11.005
31	30	30	1	24	2.571	2313.565	16.865
32	36	12	3	20	0.814	1055.224	9.492
33	40	20	2	18	0.876	1400.971	9.843
34	40	40	1	18	1.948	3116.118	14.680
35	45	15	3	16	0.911	1844.150	10.038
36	48	24	2	15	0.673	1549.929	8.627
37	60	20	3	12	0.707	2544.796	8.844
38	60	30	2	12	0.906	3262.000	10.013
39	60	60	1	12	1.720	6190.205	13.793
40	72	24	3	10	0.616	3191.778	8.254
41	80	40	2	9	0.299	1910.563	5.747
42	90	30	3	8	0.830	6722.786	9.583
43	120	40	3	6	0.288	4147.900	5.645
44	120	60	2	6	0.223	3213.200	4.969
45	180	60	3	4	0.218	7068.667	4.913

Table (9). Variance and coefficient of variability of different plot sizes and shapes for 45 combinations from 720 basic units of lentil (variety Giza 4) in 1998-99 season.

Serial no.	Plot size and shape No. of basic units			Total no. of plots	Variance		Coefficient of variability CV%
	Size	rows	strip		Per basic unit $V_x$	Among plots $V_{(x)}$	
1	1	1	1	720	9.180	9.180	46.539
2	2	1	2	360	4.701	18.803	33.303
3	2	2	1	360	5.614	22.455	36.394
4	3	1	3	240	3.406	30.650	28.346
5	3	3	1	240	4.591	41.320	32.913
6	4	2	2	180	2.723	43.569	25.347
7	4	4	1	180	3.842	61.475	30.109
8	5	5	1	144	3.633	90.834	29.279
9	6	2	3	120	1.836	66.083	20.811
10	6	3	2	120	2.211	79.584	22.838
11	6	6	1	120	3.416	122.959	28.388
12	8	4	2	90	1.956	125.153	21.480
13	8	8	1	90	2.953	189.014	26.397
14	9	3	3	80	1.593	129.021	19.386
15	10	5	2	72	1.871	187.126	21.012
16	10	10	1	72	2.758	275.782	25.508
17	12	4	3	60	1.447	208.373	18.477
18	12	6	2	60	1.738	250.263	20.250
19	12	12	1	60	2.533	364.779	24.447
20	15	5	3	48	1.414	318.160	18.266
21	15	15	1	48	2.442	549.405	24.002
22	16	8	2	45	1.574	403.031	19.273
23	18	6	3	40	1.290	417.925	17.445
24	20	10	2	36	1.438	575.200	18.420
25	20	20	1	36	2.287	914.620	23.227
26	24	8	3	30	1.163	669.638	16.562
27	24	12	2	30	1.446	832.830	18.470
28	24	24	1	30	2.173	1251.776	22.644
29	30	10	3	24	1.121	1008.821	16.262
30	30	15	2	24	1.267	1140.484	17.291
31	30	30	1	24	2.062	1855.622	22.056
32	36	12	3	20	1.063	1377.125	15.834
33	40	20	2	18	1.194	1910.250	16.784
34	40	40	1	18	1.700	2719.677	20.026
35	45	15	3	16	0.977	1977.892	15.181
36	48	24	2	15	1.186	2732.911	16.729
37	60	20	3	12	0.896	3225.716	14.540
38	60	30	2	12	1.108	3987.898	16.167
39	60	60	1	12	1.707	6146.205	20.070
40	72	24	3	10	0.922	4781.639	14.752
41	80	40	2	9	0.973	6224.625	15.148
42	90	30	3	8	0.940	7614.286	14.893
43	120	40	3	6	0.736	%10591.	13.174
44	120	60	2	6	1.027	%14784.	15.564
45	180	60	3	4	0.861	%27908.	14.256

(with 180 basic units). Similar trends were observed for the remaining data of Giza 4 in 1999/2000 and Giza 51 in both seasons as shown in Tables (9-11).

However, the reduction of these values is not in proportion with the plot size increases. As the plots become larger, the reduction rate decreases. This confirms with the fact that the relationships between plot size and the variance per basic unite or the coefficient of variability is exponential in nature. The equations describing this relationship were defined as follows:

$$CV = 46.199 x^{-0.4045} \text{ ( for Giza 4 in 1998/99 season)}$$

$$CV = 37.430 x^{-0.2103} \text{ ( for Giza 4 in 1999/2000 season)}$$

$$CV = 42.599 x^{-0.3405} \text{ ( for Giza 51 in 1998/99 season)}$$

$$CV = 55.346 x^{-0.4530} \text{ ( for Giza 51 in 1999/2000 season)}$$

Where x is the plot size.

The estimation of the optimum plot size was calculated by applied the following three methods : (1) Smith method, (2) Maximum curvature method, and (3) comparable variance method.

### **A.2.1 Smith method.**

The method developed by Smith (1938), ignoring the cost factors, calculate the optimum plot size for each of Giza 4 and Giza 51 varieties in each season. The weighted index of soil variability (b), discussed in part A.1, was used to estimate the optimum plot size

The results showed that the estimated values of the optimum plot size were 4.379 and 1.305 basic units for Giza 4

variety in 1998/99 and 1999/2000 seasons, respectively, consequently the optimum plot size was 4 and 1 basic unite in the two seasons, respectively. For Giza 51 variety, the corresponding estimates were 3.205 and 5.344 basic units in the first and the second seasons, respectively, hence the optimum plot sizes were 3 and 5 basic units for both seasons, respectively.

#### **A.2.2. Maximum curvature method.**

In this method data of average of variance per basic unit; seed yield and observed and estimated values of coefficient of variation (CV %) for each plot size combinations for Giza 4 and Giza 51 in each of 1998-1999 and 1999/2000 seasons are given in Table (12) for Giza 4 and Table (13) for Giza 51 . As indicated before the results showed that CV % values were decreased as the plot size increased from the smallest basic unit (one basic plot) to the largest plot size for both varieties in the two seasons. For example, the data of Giza 4 in 1998/99 showed that CV % decreased from 46.198 % for one basic unit ( $0.3 \text{ m}^2$ ) to 5.652% for the plot size of 180 basic units ( $54 \text{ m}^2$ ) .Similar decreases in CV % values, according to the increase in plot size, were occurred in Giza 4 and Giza 51 as shown in Tables (12 and 13) .

According to the maximum curvature method, the coefficient of variability (CV %) was used as an indicator to optimum plot size, and it graphed on the (Y) axis in relation to various plot sizes on the (X) axis (Figures 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 increment of (X) is greatest, so it called the point of maximum curvature ( $X_0$ ).

Table (12). Average of variance per basic unit ( $V_x$ ), seed yield (SY) and observed and estimated values of coefficient of variability (CV) for each plot size in lentil uniformity trails of Giza 4 at Sids Research Station in 1998/99 and 1999/2000 seasons.

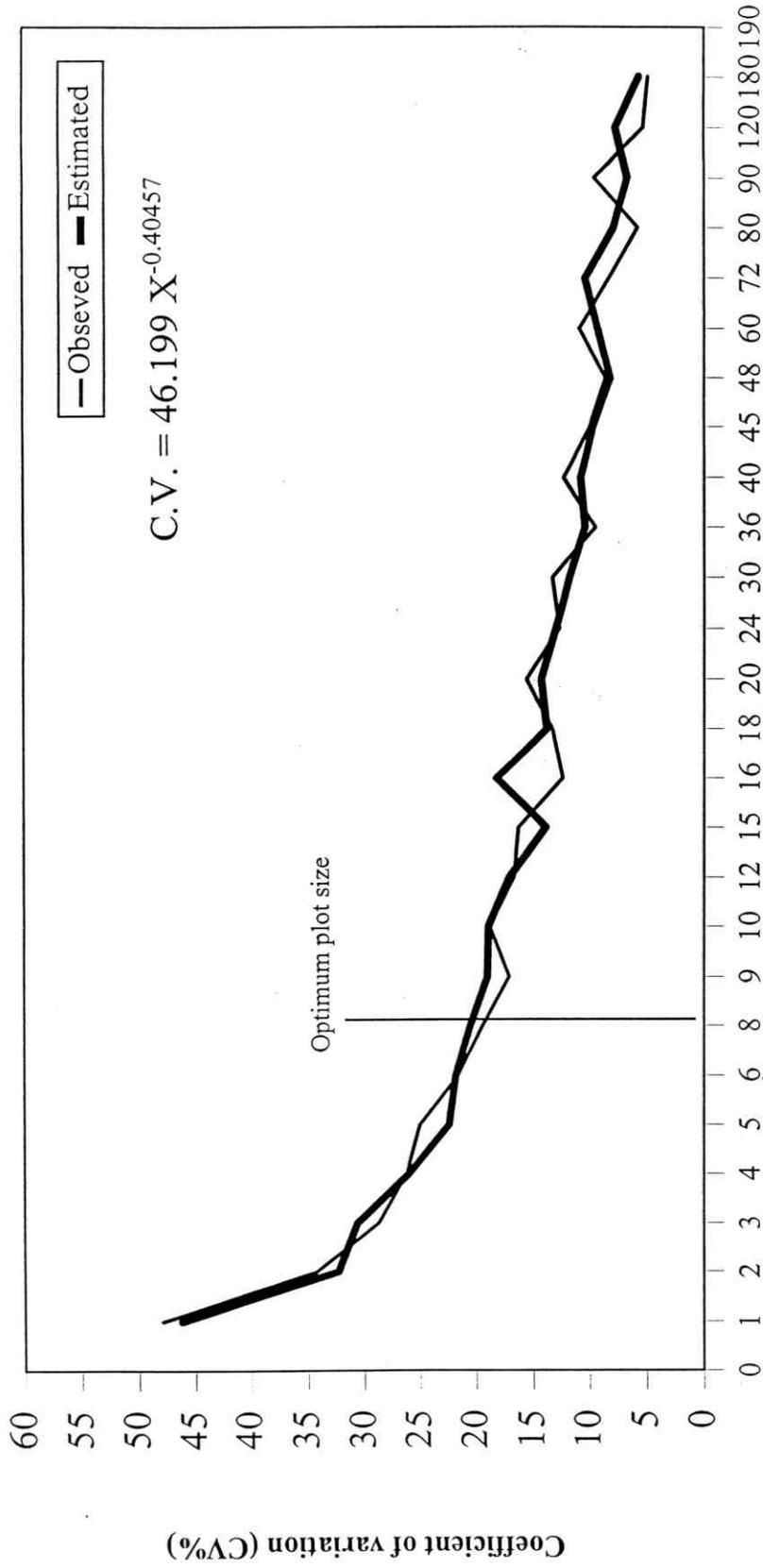
Plot Size	1998-1999				1999-2000			
	$V_x$	SY (g)	CV		$V_x$	SY (g)	CV	
			Observed	Estimated			Observed	Estimated
1	20.750	9.51	47.916	46.198	9.180	6.51	46.539	37.496
2	10.550	19.01	34.148	32.261	5.158	13.02	34.849	31.03
3	7.471	28.52	28.737	30.634	3.999	19.53	30.630	30.158
4	6.225	38.03	26.176	25.999	3.283	26.04	27.728	27.693
5	5.633	47.53	24.965	22.377	3.633	32.55	29.279	25.678
6	4.234	57.04	21.586	21.759	2.488	39.06	24.012	25.238
8	3.417	76.05	19.412	20.498	2.455	52.08	23.939	24.439
9	2.638	85.56	17.085	18.992	1.593	58.59	19.386	23.063
10	3.225	95.07	18.756	18.912	2.315	65.10	23.26	23.428
12	2.536	114.08	16.713	17.057	1.906	78.12	21.058	22.249
15	2.441	142.60	16.305	13.910	1.928	97.65	21.134	20.038
16	1.397	152.11	12.433	18.199	1.574	104.16	19.273	23.063
18	1.601	171.12	13.311	13.749	1.290	117.19	17.445	19.934
20	2.217	190.14	15.588	14.287	1.863	130.21	20.824	20.25
24	1.529	228.16	12.735	13.019	1.594	156.25	19.225	19.326
30	1.658	285.20	13.300	11.774	1.483	195.31	18.536	18.349
36	0.814	342.25	9.492	10.387	1.063	234.37	15.834	17.230
40	1.412	380.27	12.262	10.793	1.447	260.41	18.405	17.503
45	0.911	427.81	10.038	9.648	0.977	292.96	15.181	16.582
48	0.673	456.33	8.627	8.188	1.186	312.49	16.729	15.227
60	1.111	570.41	10.883	9.322	1.237	390.62	16.926	16.219
72	0.616	684.49	8.254	10.387	0.922	468.74	14.752	17.230
80	0.299	760.54	5.747	7.847	0.973	520.82	15.148	14.893
90	0.830	855.61	9.583	6.660	0.940	585.92	14.893	13.676
120	0.256	1140.82	5.307	7.738	0.882	781.23	14.369	14.749
180	0.218	1711.2	4.913	5.652	0.861	1171.9	14.256	12.558

Plot size : No of basic units.

Table (13). Average of variance per basic unit ( $V_x$ ), seed yield (SY) and observed and estimated values of coefficient of variability (C.V.) for each plot size in lentil uniformity trails of Giza 51 at Sids Research Station in 1998/99 and 1999/2000 seasons.

Plot Size	1998-1999				1999-2000			
	$V_x$	SY (g)	CV		$V_x$	SY (g)	CV	
			Observed	Estimated			Observed	Estimated
1	15.885	8.26	48.258	42.599	9.313	5.87	52.003	55.346
2	8.536	16.52	35.36	31.475	4.958	11.74	37.912	37.039
3	6.178	24.78	30.078	30.108	3.533	17.60	31.997	34.984
4	4.695	33.04	26.174	26.226	2.882	23.47	28.871	29.114
5	4.848	41.30	26.659	23.146	2.568	29.34	27.306	24.580
6	3.341	49.55	22.072	22.573	1.968	35.21	23.811	23.856
8	3.121	66.07	21.265	21.454	1.738	46.95	22.354	22.326
9	2.143	74.33	17.727	19.451	1.249	52.81	19.041	19.502
10	2.749	82.59	19.997	20.045	1.416	58.68	20.099	20.405
12	2.218	99.11	17.826	18.396	1.164	70.42	15.239	18.159
15	1.932	123.89	16.805	15.506	1.110	88.02	17.896	14.44
16	1.867	132.14	16.542	19.451	0.794	93.89	15.180	19.502
18	1.148	148.66	12.973	15.362	0.587	105.63	13.053	14.247
20	1.767	165.18	15.992	15.831	0.985	117.36	16.737	14.906
24	1.562	198.22	15.048	14.652	0.703	140.84	14.028	13.422
30	1.105	247.77	12.522	13.466	0.654	176.05	13.495	11.99
36	0.972	297.33	11.937	12.133	0.289	211.26	9.161	10.408
40	1.333	330.36	13.89	12.503	0.627	234.73	13.103	10.890
45	0.682	371.66	9.999	11.402	0.258	264.07	8.653	9.242
48	0.821	396.43	10.970	9.932	0.277	281.67	8.969	10.408
60	0.946	495.54	11.528	11.052	0.386	352.09	10.225	7.603
72	0.625	594.65	9.573	12.133	0.151	422.51	6.610	10.408
80	0.562	660.72	9.073	9.582	0.169	469.46	7.012	7.603
90	0.483	743.31	8.417	8.347	0.124	528.14	5.994	6.327
120	0.517	991.08	8.696	9.458	0.113	704.18	5.693	7.494
180	0.526	1486.6	8.785	7.270	0.069	1056.3	4.471	5.266

Plot size : No of basic units.



Plot size (number of basic units)  
**Fig. 1. Relation between plot size and coefficient of variation for Giza 4 in 1998-99.**

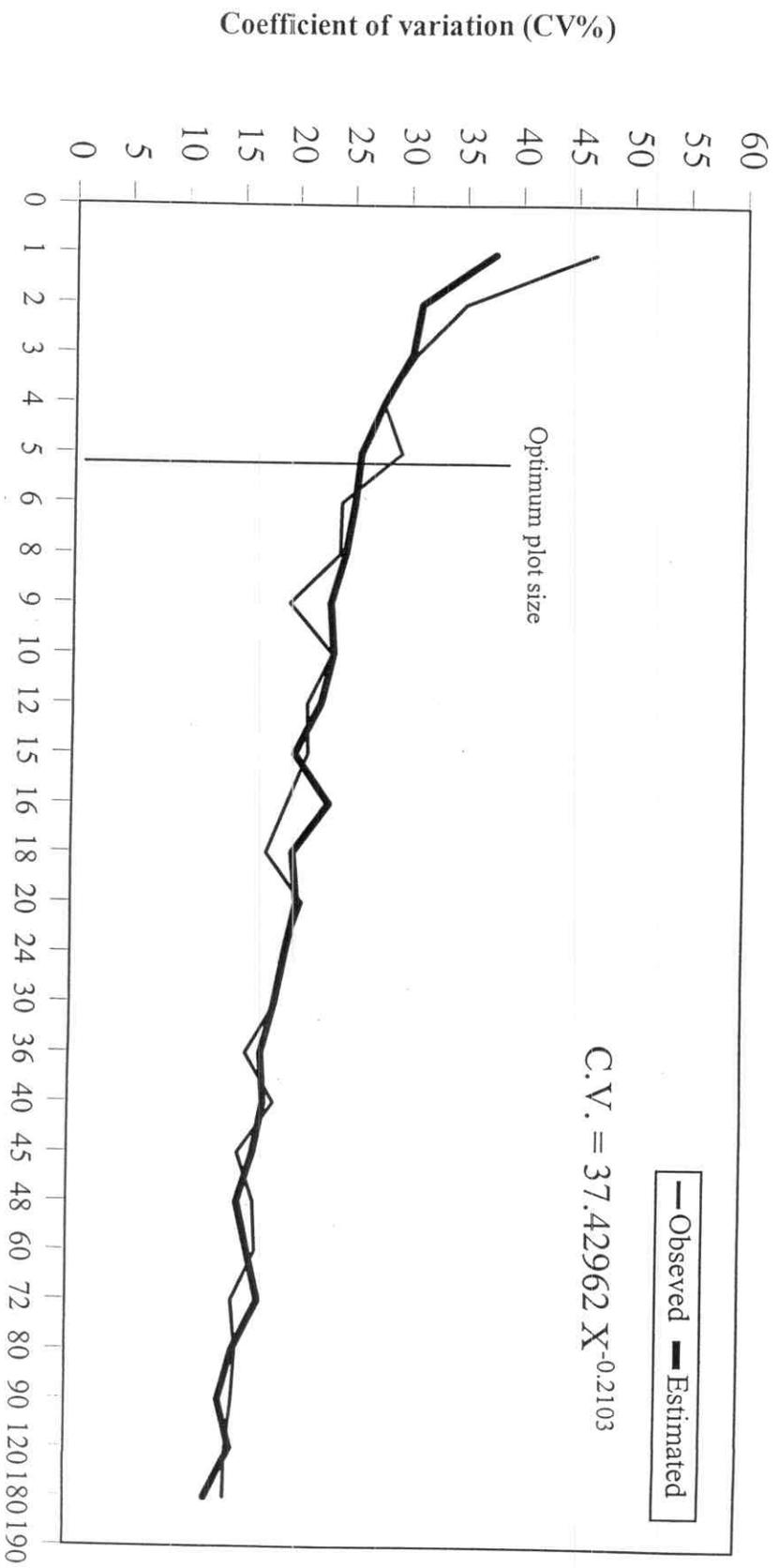


Fig. 2. Relation between plot size and coefficient of variation for Giza 4 in 1999-2000.

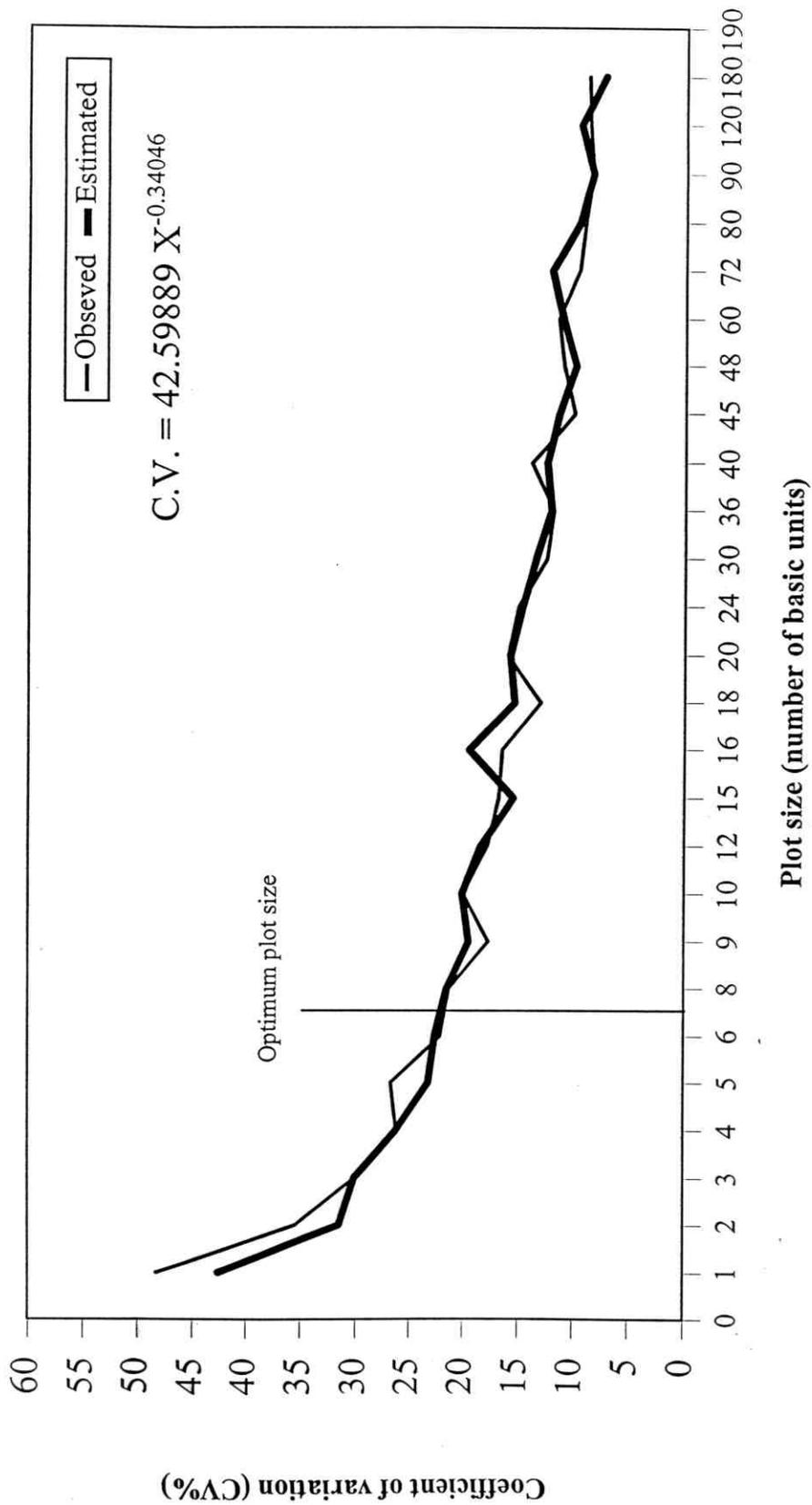


Fig. 3. Relation between plot size and coefficient of variation for Giza 51 in 1998-99.

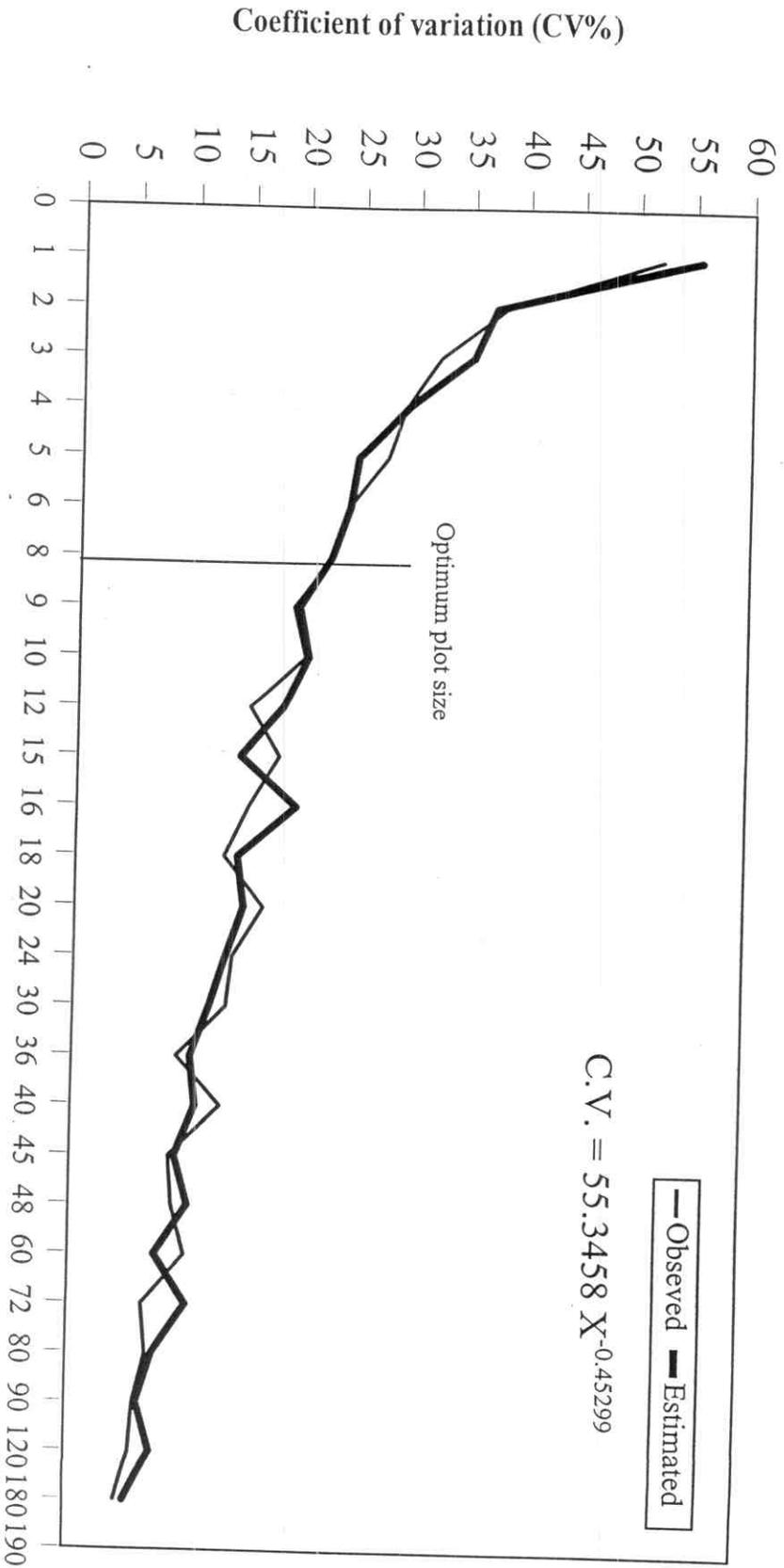


Fig. 4. Relation between plot size and coefficient of variation for Giza 51 in 1999-2000.

For Giza 4 variety, the results of the relation between plot size and coefficient of variation showed that the point of maximum curvature method ( $x_0$ ) is 8 basic units in 1998/99 season (Fig.1) and 5 basic units in 1999/2000 season (Fig.2) while the values of ( $x_0$ ) of Giza 51 were 7 and 8 basic units in 1998/99 and 1999/2000 seasons, respectively (Figs.3 and 4).

### **A.2.3. Comparable variance method.**

In this method the variance between plots ( $V_x$ ) was calculated for each type of plot combination (from one basic unite to 40 basic units), then allocated divided by the number of basic units per plot ( $X$ ), so that the variance would be compared with that of the individual basic unit plot. Comparable variance ( $V$ ) of each plot size was compared with the comparable variance of individual basic unit as percent relative information (RI). The variance of individual basic units was assumed to contribute 100 % relative information (RI).

The values of ( $V$ ) and (RI) for different plot size (number of basic units from 1-40 for Giza 4 and Giza 51 in both seasons were presented in Table (14). The data showed that as plot size increased, the variance ( $V$ ) of seed yield per unit area increased, while the relative information values (RI) decreased. For example, the values of comparable variance increased from 20.75 (for one basic unit) to 56.48 (for 40 basic units) of Giza 4 in 1998/99 season. Similarly, ( $V$ ) values of Giza 4 in 1999/2000 increased from 9.18 to 28.94. Similar trend was occurred on Giza 51 in both seasons (Table 14). Regarding the values of (RI), the data in Table (14) showed that (RI) of Giza 4

Table (14) . Comparable variance (V) and relative information estimates (RI) for various polt sizes (1-40 ) in basic units, for Giza 4 and Giza 51 lentil varieties in 1998/99 and 1999/2000 seasons.

No. of basic units	Giza 4				Giza 51			
	1998/99		1999/2000		1998/99		1999/2000	
	V	RI	V	RI	V	RI	V	RI
1	20.750	100.0	9.180	100.0	15.885	100.0	9.313	100.0
2	21.1	98.3	10.316	88.99	17.072	93.05	9.916	93.92
3	22.41	92.6	11.997	76.52	18.534	85.71	10.599	87.87
4	24.9	83.3	13.132	69.91	18.78	84.58	11.528	80.79
5	28.165	73.67	18.165	50.54	24.24	65.53	12.84	72.53
6	25.404	81.68	14.928	61.50	20.046	79.24	11.808	78.87
8	27.336	75.91	19.64	46.74	24.968	63.62	13.904	66.98
9	23.742	87.40	14.337	64.03	19.287	82.36	11.241	82.85
10	23.25	89.25	23.15	39.65	27.49	57.78	14.16	65.77
12	30.432	68.18	22.872	40.14	26.616	59.68	13.97	66.66
15	36.615	56.67	28.92	31.74	28.980	54.81	16.650	55.93
16	22.352	92.83	25.184	36.45	29.872	53.18	12.704	73.31
18	28.818	72.00	23.22	39.53	20.664	76.87	10.566	88.14
20	44.34	46.80	37.26	24.64	35.34	44.95	19.7	47.27
40	56.48	36.74	28.94	31.72	53.32	29.79	25.08	37.13

Basic unit : 0.3 m<sup>2</sup>

in the first season was decreased from 100 % for individual basic unit to 98.3 % (for 2 basic units), to 92.6 % (for 3 basic units) and continued decreased as the plot size increased till 5 basic units, where (RI) value reached 73.67 % .Then ( RI) value of the following plot size increased again. Similar trends were observed for other data of Giza 4 in the second season, and for Giza 51 in both seasons as presented in table Table (14) .

Therefore, these data indicated that the mean decrease in (RI) values on an individual unit differences, is less noticeable as the plot size increased beyond 5 basic units for both varieties in both seasons. The data further showed that the relative information values (RI) changed only a relatively small amount after this point (5 basic units ). Some abnormal values of (RI) were occurred, which may be due to the heterogeneity of the soil (i.e. the large estimates of b ).

Regarding the three methods used to calculate the optimum plot size, the estimated values of optimum plot size by three methods calculated as number of basic units, optimum plot area in  $m^2$  and per feddan are summarized in Table (15) .

It could be concluded that, the optimum plot size for Giza 4 is ranged from one basic unit ( $0.3 m^2$ ) to 8 basic units ( $2.4 m^2$ ) with an average of 4.5 basic units ( $1.35 m^2$ ), which equal to 1/14000 to 1/1750 per feddan with an average of 1/4660 per feddan. For Giza 51 variety, the corresponding values were close to that of Giza 4, where the optimum plot size were ranged from 3 basic plots ( $0.9 m^2$ ) to 8 basic plots ( $2.4 m^2$ ) with an average of 5.5 basic plots ( $1.65 m^2$ ), which equal to 1/2803 per feddan (Table 15).

Table (15). Otimum plot size for the two lentil varieties Giza 4 and Giza 51 as calculated by Smith, maximum curvature and comparable variance methods in 1998/99 and 1999/2000 seasons.

Estimated method	Giza 4		Giza 51	
	1998/99	1999/2000	1998/99	1999/2000
	No. of basic units			
Smith	4	1	3	5
Maximum curvature	8	5	7	8
Comparable variance	5	5	5	5
Range	1-8		3-8	
Average	4.5		5.5	
	Area m <sup>2</sup>			
Smith	1.2	0.3	0.9	1.5
Maximum curvature	2.4	1.5	2.1	2.4
Comparable variance	1.35	1.5	1.5	1.5
Range	0.3-2.4		0.9-2.4	
Average	1.38		1.65	
	Area per feddan			
Smith	1/3500	1/14000	1/4667	1/2800
Maximum curvature	1/1750	1/2800	1/2000	1/1750
Comparable variance	1/3111	1/2800	1/2800	1/2800
Range	1/14000-1/1750		1/4667-1/1750	
Average	1/4660		1/2803	

Basic unit : 0.3 m<sup>2</sup>

Since the methods of determining the optimum plot size are based on different criteria, it is expected that the estimate of the optimum plot size may not agree with each other. However, they should provide a range of optimum values that permit greater flexibility and convenience to the research workers in choosing the size which enable them to detect differences of specified magnitudes between treatment means provided that the number of treatments and the experimental design are known.

In addition, The various estimates of optimum plot size between methods, varieties and seasons may be due to the fact that plot size estimates affected by several factors, such as, crop species, variety, location, agricultural practices, size of the basic unit used, and the statistical procedures using to estimate plot size. Therefore, many researchers reported different estimates of optimum plot sizes according to variation of one or more of the factors mentioned above. For Example, the data of previous work showed that a range of 5-8 basic units were the optimum in cotton crop (Galal and Abou- El-Fittouh, 1971). In other studies the optimum plot size in faba been was 3 basic units, 1.8 m<sup>2</sup> (Khalil *et al.*, 1973), and 5-6 basic units or 7.5-9 m<sup>2</sup> in sesame (Ali, 1983). Abd- El-Halim *et al.* (1989) found that one basic unit (1.2 m<sup>2</sup>) and two basic units (2.4m<sup>2</sup>) were the optimum plot size for faba been in 1985-86 and in 1986-87 seasons, respectively. Different estimates of plot size due to various methods application was also reported by Meier and Lessman (1971), who found that 6.7 m<sup>2</sup> was the optimum plot size when smith methods used, while 5.4 m<sup>2</sup> plot size was the optimum when curvature technique applied in crambe crop. Similarly, in onion crop the optimum plot sizes were 5.4 m<sup>2</sup> and 7.2 m<sup>2</sup> when

Smith and curvature method have been used, respectively ( **El-Kalla *et al.*, 1981**). It worth while to mention that, lentil crop need small plot size comparing with 12 field crops as reported by **El-Bakry (1980)**.

It should be mentioned that if the new procedures for handling lentil experiments are adopted in the future, the different experimental procedures may change, and optimum plot size may also change.

### **A.3. Determination of the optimum plot shape.**

To determine the optimum pot shape, the variance ratios (F) of the various 33 combinations of plot shape for the different 14 plot sizes were calculated and presented in Table (16 ) for Giza 4 and Table (17) for Giza 51. These “F” values were compared with the tabulated values at the same degrees of freedom to measure the difference among plot shapes composed of the same number of basic units.

The results in Tables (16 and 17) indicated that the variances for various plot shapes did not differ significantly in all cases for both varieties in the seasons . Therefore, the plot shape of lentil experiments in the present study had no effect.

Similar results were obtained in pervious studies reported by **Galal and Abou-El-Fittouh (1971)**, **El-Gamal (1972)**, and **El-Gamal *et al.* (1990)** in cotton .

The results obtained in the present study indicated that the plot size ranged from 1.38 to 1.65 m<sup>2</sup> is desirable to be adopted in lentil field experiments. Since lentil crop is planted in dense population (about 330 plants /m<sup>2</sup>), the obtained plot size contains

about 445 to 445 plants which is enough to represent the crop population . In this regard, the optimum plot size, in general, should be reached on the basis of both practicability and statistical efficiency . Practically, experimental plots should be sufficiently large to include representative sample of the crop population and allow the elimination of border effects if they exist. Plot size should be also sufficient to minimize the effects of slight discrepancies in soil, stand and handling of the experimental materials. In addition, the size and shape of field plots should allow the use of standard machinery. However, there is a tendency to reduce the size of field plots of lentil experiments, so the researchers may have a better control over the experimental materials and take more observations which will be of great value in interpreting the results.

Worthwhile, optimum plot size of plot derived from purely statistical procedures depends on several factors which include environmental and/or genetical in nature which introduce considerable fluctuations in the estimated optimum size. These factors include the statistical procedure used, Since different procedures will lead to various estimates as obtained in the present study. Also the estimated plot size is dependent on the size of the basic unit used in uniformity trials. Variety, location, season and agricultural practices will also affect the obtained results as indicated.

Therefore, in view of obtained results and all factors mentioned above, it may be recommended that a lentil plot should consists at least 4 adjacent rows of 3 m long with 30 cm apart with a plot size equal to  $3.6 \text{ m}^2$  (  $1.2\text{m} \times 3 \text{ m}$  ), where 50 cm from each end-row and 2 rows from side-plot will be

discarded latter as a border. While, plot shape is generally unimportant. It should be noted that, currently, the lentil Breeding program at agricultural Research Center is using in yield trials plots consisting of 4 rows 3 m long and 30 cm apart. This is approximately meets our recommendation and it is optimum to improve precision of lentil experiments.

### **B. Estimation of the optimum plant sample size.**

In this part two lentil experiments were conducted at Giza and Sids Research Stations, to compare between five plant sample sizes (10, 20, 30, 40 and 50 plants/plot) and the whole plant-plot population to determine the optimum plant sample size for measuring different lentil characters. In these experiments the two varieties Giza 4 and Giza 51, which used in the first part, were also used.

The individual analysis of variance (not tabulated) for each genotype in every location for the seven lentil characters which estimated on the basis of individual plants of each sample size (seed yield/plant, biological yield/plant, straw yield/plant, number of pods/plant, number of seeds/plant, plant height and number of branches/plant) showed significant differences among all plant sample size treatments except number of seeds/plant for Giza 4 at Giza Research Station, seed yield/plant and number of seeds/plant for Giza 4 at Sids Research Station.

The combined analysis of variance over locations, varieties and plant sample sizes and their interactions for the seven lentil characters estimated on the basis of individual plants are presented in Table (18). While, the combined analysis of

Table (18). Mean squares for combined analysis of variance of seed yield (g)/plant (SY), biological yield (g)/plant (BY), straw yield (g)/plant (STY), number of pods/plant (pods), number of seeds/plant (Seeds), plant height (PLHT) and number of branches/plant (BRPL) estimated on the individual plant sample-plot basis.

Source of variance	d.f.	Mean Square							
		SY	BY	STY	Pods	Seeds	PLHT (cm)	BRPL	
Replication	3	0.004 <sup>NS</sup>	1.331 <sup>NS</sup>	0.845 <sup>NS</sup>	34.968 <sup>NS</sup>	58.540 <sup>NS</sup>	18.773 <sup>NS</sup>	5.819 <sup>NS</sup>	
Location (L)	1	3.212 <sup>**</sup>	146.397 <sup>**</sup>	148.927 <sup>**</sup>	8156.750 <sup>**</sup>	7722.094 <sup>**</sup>	596.505 <sup>*</sup>	158.775 <sup>**</sup>	
Error (a)	3	0.016	0.162	0.328	45.971	40.606	46.237	5.956	
Variety (V)	1	0.721 <sup>**</sup>	1.438 <sup>NS</sup>	1.231 <sup>NS</sup>	2047.030 <sup>**</sup>	1576.261 <sup>**</sup>	359.988 <sup>*</sup>	54.391 <sup>**</sup>	
LV	1	0.109 <sup>*</sup>	3.394 <sup>NS</sup>	0.000 <sup>NS</sup>	144.305 <sup>*</sup>	405.082 <sup>NS</sup>	234.063 <sup>*</sup>	0.592 <sup>NS</sup>	
Error (b)	6	0.018	2.156	0.759	13.726	84.838	33.048	4.767	
Sample size (S)	5	0.168 <sup>**</sup>	10.253 <sup>**</sup>	11.100 <sup>**</sup>	142.040 <sup>**</sup>	191.981 <sup>**</sup>	30.530 <sup>*</sup>	1.688 <sup>NS</sup>	
LS	5	0.219 <sup>**</sup>	1.024 <sup>NS</sup>	0.576 <sup>*</sup>	82.763 <sup>**</sup>	140.468 <sup>*</sup>	13.364 <sup>NS</sup>	1.501 <sup>NS</sup>	
VS	5	0.065 <sup>**</sup>	1.575 <sup>*</sup>	0.412 <sup>NS</sup>	7.084 <sup>NS</sup>	90.513 <sup>NS</sup>	16.716 <sup>NS</sup>	2.593 <sup>NS</sup>	
LVS	5	0.020 <sup>NS</sup>	1.240 <sup>NS</sup>	0.745 <sup>*</sup>	42.978 <sup>*</sup>	136.227 <sup>*</sup>	6.051 <sup>NS</sup>	2.114 <sup>NS</sup>	
Error (c)	60	0.017	0.598	0.243	14.063	58.937	11.417	1.624	

<sup>\*</sup>, <sup>\*\*</sup> Significant at 0.05 and 0.01 levels of probability, respectively.  
NS: Not Significant.

other four lentil characters (number of seeds/pod, 100-seed weight, days to 50 % flowering and days to 90 % maturity), which estimated on the whole plant-plot population basis is given are Table (19).

The combined analysis of variance presented in Table (18) and (19) showed significant effect of location on all studied characters, except number of seeds/pod and days to maturity.

Table (19). Mean squares for combined analysis of variance of number of seeds/pod (SP), 100-seed weight (100 SW), days to 50 % flowering (DFL), and days to 90 % maturity (DMAT) estimated on the whole plant-plot population basis.

Source of variance	d.f	SP	100 SW (g)	DFL (days)	DMAT (days)
Replication	3	0.005 <sup>NS</sup>	0.019 <sup>NS</sup>	3.486 <sup>NS</sup>	3.292 <sup>NS</sup>
Location (L)	1	0.091 <sup>NS</sup>	3.413 <sup>**</sup>	1520.042 <sup>**</sup>	13.500 <sup>NS</sup>
Error (a)	3	0.026	0.001	11.597	2.528
Variety (v)	1	0.024 <sup>NS</sup>	0.038 <sup>NS</sup>	0.167 <sup>NS</sup>	40.042 <sup>*</sup>
LV	1	0.012	0.018 <sup>NS</sup>	8.167 <sup>NS</sup>	0.167 <sup>NS</sup>
Error (b)	6	0.028	0.022	11.444	4.299

<sup>\*</sup>, <sup>\*\*</sup> Significant at 0.05 and 0.01 levels of probability, respectively.

NS: Not significant.

The variety effect was also significant for all studied characters except in biological and straw/plant, number of seeds/pod, 100-seed weight, and days to flowering. The interaction effect of location x variety was significant only in seed yield/plant, number of pods/plant and plant height. While, the sample size

effect was significant in all studied characters, except number of branches/plant (Table 18). The first order interaction of location x sample size (LS) and variety x sample size (VS) and the second order interaction of location x variety x sample size (LVS) were significant in some studied characters as shown in Table (18).

The significant values of variance for location, varieties and their interactions indicated high location effect on the performance of most studied characters. In addition, the significant values of variance for varieties, sample size and variety x sample size interaction reflect the various performances of varieties, sample size and their interaction. The relative importance and the performance of all of these various sources of variance will be discussed for each factor separately.

### **B.1. Location effects on lentil characters.**

In the present study the two locations studied were Giza and Sids Research Stations. The overall means of 11 lentil characters measured in both locations are given in Table (20).

The mean square values of various characters for location effect presented in Tables (18 and 19) were higher in magnitudes than the mean squares of other sources of variation (varieties, sample sizes and all interactions), indicating the predominant effects of locations on the performance of all lentil characters, except days to 90 % maturity.

The data in Table (20) showed that Giza performed higher values of all characters than Sids, except for 100-seed weight. For example, seed yield/plant at Sids was 0.564 g, while it was 0.930 g/plant at Giza, giving an increase of 64.9 %. Similarly,

Table (20). Location effect on the performances of 11 lentil characters overall varieties and sample size.

Character	Location		L.S.D. 5 %
	Giza	Sids	
Seed yield (g)/plant	0.930	0.564	0.083
Biological yield (g)/plant	5.401	2.931	0.261
Straw yield (g)/plant	4.667	2.176	0.372
No. of pods/plant	35.300	16.870	4.404
No. of seeds/plant	46.990	29.050	4.139
No. of seeds/pod	1.550	1.490	NS
100-seed weight (g)	1.760	2.140	0.020
Plant height (cm)	53.020	48.030	4.416
No. of branches/plant	6.390	3.820	1.590
Days to 50 % flowering	75.500	67.500	2.210
Days to 90 % maturity	138.400	139.400	NS

NS : Not significant

biological and straw yield/plant values at Giza were higher than the corresponding values at Sids by 84.3 and 114.5 %, respectively. The increase of seed yield at Giza was due to increasing of the two yield component characters number of pods and seeds/plant. As shown in Table (20), the values of both

characters at Giza exceeded the corresponding values at Sids by 109.3% and 61.8 %, respectively. Although, 100-seed weight at Sids was slightly higher than that at Giza, it had no effect on seed yield at Giza due to the superiority of pods and seeds/plant at Giza. The highest estimates of straw yield/plant at Giza was mainly due to increasing of both plant height and number of branches/plant. The estimated values of both characters at Giza were 53.02 cm and 6.39 branches/plant, respectively, while the corresponding values at Sids were 48.03 cm and 3.82 branches/plant, respectively.

The superiority of lentil characters at Giza Research Station obtained in the present study may be due to the higher soil fertility at Giza comparing with the soil fertility at Sids.

As indicated in Table (2), the silt and clay components in the soil at Giza were higher than those at Sids. In addition, chemical analysis of the soil showed that higher amount of elements and available nutrients were existed in the soil at Giza, which indicated its higher soil fertility and hence confirmed the obtained results.

Despite that only two locations were used in the present study, the obtained results revealed that wide difference between locations was existed for yield, yield components and most other studied characters. These results suggesting the possibility of increasing yield levels through improved management practices such as soil fertility, fertilization, ..... etc.)

The above results are agreed with those previously reported by many researchers, who found important location effects on performance of lentil characters (Pandey *et al.*, 1982;

Ahmed and Pandey, 1983; Erskine, 1983; Mohamed *et al.*, 1989; Hamdi *et al.*, 1991a; Hamdi and Rabeia, 1991 and Hamdi *et al.*, 1992). Hamdi *et al.* (1991b) found that the variance of locations represented a major proportion of total variance of seed yield in lentil. They explained that by the fluctuations in the environmental conditions occurred throughout their experiments.

#### **B.2. Differences between the tested varieties Giza 4 and Giza 51.**

The combined analysis of variance presented in Table (18 and 19) revealed significant differences between varieties for all studied characters, except biological yield/plant, straw yield/plant, number of seeds/pod, 100-seed weight and days to 50 % flowering. These results indicated the presence of substantial differences between Giza 4 and Giza 51 for some of studied characters. The average performance of both varieties, overall locations and sample sizes, for all studied characters are given in Table (21).

The results presented in Table (21) showed that the variety Giza 4 gave average seed yield of 0.660 g/plant, while Giza 51 exhibited seed yield/plant of 0.834 g with a yield increase of 26.4 %. The seed yield increase of Giza 51 was due to increasing of its number of pods and seeds/plant. This variety had an increase of 43% for pods/plant and 23.9% for seeds/plant over Giza 4. The variety Giza 4 was taller than Giza 51, as the plant height estimates of both varieties were 52.47 and 48.59 cm, respectively. While, Giza 51 performed slightly more branches than Giza 4. However, both varieties were flowered and matured almost at equal times.

Table (21). Average performance of Giza 4 and Giza 51, overall locations and sample sizes, for 11 lentil characters.

Character	Varieties		L.S.D. 5 %
	Giza 4	Giza 51	
Seed yield (g)/plant	0.660	0.834	0.066
Biological yield (g)/plant	4.044	4.289	NS
Straw yield (g)/plant	3.309	3.535	NS
No. of pods/plant	21.470	30.700	1.850
No. of seeds/plant	33.970	42.070	4.601
No. of seeds/pod	1.540	1.510	NS
100-seed weight (g)	1.930	1.970	NS
plant height (cm)	52.470	48.590	2.870
No. of branches/plant	4.360	5.860	1.090
Days to 50 % flowering	71.500	71.600	NS
Days to 90 % maturity	138.400	139.700	1.040

NS : Not significant

It worthwhile to mention that, these two varieties has been released recently in 1998. Both varieties exceeded the lentil widespread cultivar Giza 9, where their seed yield increase over Giza 9 was 10 % for Giza 4 and 12 % for Giza 51. In addition, Giza 4 characterized as resistant to root-rot and wilt diseases and Giza 51 is also resistant to these diseases beside its better ability to seed splitting than Giza 9 (Hamdi, 1996).

### B.3. Optimum plant sample size for various lentil characters.

As shown in Table (18), the combined analysis of variance revealed that the differences between different sample sizes were significant for all characters, except number of branches/plant. Also, the data in Table (18) showed significant differences of variance due to the first order interactions of location x sample size (LS) and variety x sample size (VS) and the second order interaction of location x variety x sample size (LVS) for some of studied characters. The significant values of variance for these interactions reflect the importance of location and variety effects on determination of optimum plant-sample size. For comparison between characters, the estimates of phenotypic coefficient of variation of sample size for the characters measured on the basis of individual plants are given in Table (22). In the following part, the differences between sample sizes and their interactions with locations and varieties will be discussed for each character.

**Table (22). Estimates of phenotypic coefficient of variation (PCV %) of sample size for studied characters.**

Character	PCV %
Seed yield (g)/plant	54.87
Biological yield (g)/plant	76.86
Straw yield (g)/plant	97.36
No. of pods/plant	45.70
No. of seeds/plant	36.45
plant height (cm)	10.94
No. of branches/plant	25.44

### **B.3.1. Seed yield per plant.**

The average performances of seed yield (g)/plant for the five sample sizes comparing with the whole plot-plants of the two varieties Giza 4 and Giza 51 at each of Giza and Sids and their combined data are given in Table (23). The whole plot sample, which consisted all plants in the plot, was considered as a check or control. The optimum plant-sample size is that which not differed significantly from the whole plot sample.

The presented data in Table (23) revealed that at Giza Research Station the average seed yield/plant of 10 plant-sample size was the only sample size which had significant difference with seed yield/plant of the whole plot plants. While all other sample sizes of 20, 30, 40 and 50 plant-sample sizes showed no significant differences with the whole plot plants treatment, Thus, all these sample sizes considered optimum. Similar trend was observed for the variety Giza 51 at Giza, where all plant-sample sizes had no significant differences with the whole plot plants, except the sample size of 10 plants.

At Sids Research Station, varied trend was observed, where the plant-sample sizes of 10, 20 and 50 had no significant differences with the whole plot plants for both varieties. This varied trend between Giza and Sids is mainly due to the significant interaction between location x sample size as indicated in Table (18).

The combined data, overall varieties, at Giza and Sids in Table (23) showed that at Giza the two samples of 10 and 50 plants were differed significantly from the whole plot plants, while all other sample sizes showed insignificant differences

Table (23). Average of seed yield (g)/plant for five sample sizes comparing with the whole plot plants of the two varieties Giza 4 and Giza 51 grown at Giza and Sids Research Stations and their combined data in 1999/2000 season.

Variety	Location	Sample size (number of plants)					Whole plot plants	Average
		10	20	30	40	50		
<b>Giza Research Station</b>								
Giza 4		1.190 <sup>A</sup>	0.938 <sup>B</sup>	0.752 <sup>BC</sup>	0.723 <sup>C</sup>	0.888 <sup>BC</sup>	0.772 <sup>BC</sup>	0.877
Giza 51		1.430 <sup>A</sup>	0.942 <sup>BC</sup>	0.745 <sup>C</sup>	0.863 <sup>BC</sup>	1.070 <sup>B</sup>	0.847 <sup>BC</sup>	0.983
<b>Sids Research Station</b>								
Giza 4		0.383 <sup>BC</sup>	0.415 <sup>ABC</sup>	0.633 <sup>A</sup>	0.542 <sup>AB</sup>	0.410 <sup>ABC</sup>	0.280 <sup>C</sup>	0.444
Giza 51		0.730 <sup>B</sup>	0.627 <sup>BC</sup>	0.527 <sup>C</sup>	0.863 <sup>A</sup>	0.680 <sup>B</sup>	0.680 <sup>B</sup>	0.685
<b>Combined</b>								
Giza station		1.310 <sup>A</sup>	0.940 <sup>BC</sup>	0.749 <sup>D</sup>	0.793 <sup>CD</sup>	0.979 <sup>B</sup>	0.810 <sup>CD</sup>	0.930
Sids station		0.556 <sup>B</sup>	0.521 <sup>B</sup>	0.580 <sup>B</sup>	0.703 <sup>A</sup>	0.545 <sup>B</sup>	0.480 <sup>B</sup>	0.564
Overall		0.933 <sup>A</sup>	0.731 <sup>BCD</sup>	0.664 <sup>CD</sup>	0.748 <sup>BC</sup>	0.762 <sup>B</sup>	.645 <sup>D</sup>	0.747

Means not followed by the same letter are significantly different at 0.05 level.

As shown in Table (18), there were significant differences among plant-sample sizes for biological yield/plant. The data in Table (24) indicated that when comparing between the average biological yields of the various plant-sample sizes, on one side, and the average of biological yield/plant estimated by the whole plot plants, on the other side, we found that all sample sizes had significant differences from the whole plot plants. That was true in all cases as in Giza 51 at Giza research Station, Giza 4 and Giza 51 at Sids Research Station and at Giza and Sids as well as the overall data, except the average of sample sizes for Giza 4 at Giza Research Station. Interestingly, this data indicated that biological yield/plant in lentil is invalid to be estimated by selective individual plants, even with 50 plants/sample.

Thus this character should be estimated through the whole plot plants. In fact, biological yield character is combined the seeds and the straw yields together, and it seems that biological yield/plant was more influenced by environmental conditions than seed yield/plant and hence had more variation than seed yield character. That was confirmed by high value of phenotypic coefficient of variation (PCV %) of biological yield/plant which was 76.86 % comparing with 54.87 % for seed yield/plant (Table 22).

### **B.3.3. Straw yield per plant.**

The combined analysis of variance revealed significant differences among sample sizes for straw yield/plant and location x sample size and location x variety x sample size interactions (Table 18). The average performance of straw

yield/plant for all sample sizes of varieties and locations and their combined data are presented in Table (25).

The data in Table (25) showed that there were significant differences among sample sizes in all cases, as in Giza 4 and Giza 51 at each location, and in the overall averages of combined data. On the other hand, the data showed also that all plant-sample sizes at all cases have significant differences with the averages of whole plot plant. These results indicated that no plant-sample size is valid to represent the whole plot plants. The data suggested again that straw yield/plant should be estimated through the whole plot plants.

These results are similar to those obtained for biological yield/plant. The estimated value of phenotypic coefficient of variation for straw yield/plant was the highest values among all studied characters and reached 97.36 % (Table 22). Worthwhile, both biological yield/plant and straw yield/plant have the highest values of (PCV) and in the same time both characters are invalid to estimated by plant-samples and should be estimated by the whole plot plants. It seems that the characters, which have large variations, need large plant samples to represent the whole population perfectly.

#### **B.3.4. Number of pods per plant.**

The combined analysis of variance of pods/plant indicated significant differences among sample sizes and for the interactions of location x sample size and location x varieties x sample size (Table 18). The average performances of number of pods/plant for the five sample sizes and the whole plot- plants of

Table (25). Average of straw yield (g)/plant for five sample sizes comparing with the whole plot plants of the two varieties Giza 4 and Giza 51 grown at Giza and Sids Research Stations and their combined data in 1999/2000 season.

Variety Location	Sample size (number of plants)				Whole plot plants	Average
	10	20	30	40		
<b>Giza Research Station</b>						
<b>Giza 4</b>	4.688 <sup>B</sup>	4.472 <sup>BCD</sup>	3.850 <sup>CD</sup>	3.670 <sup>D</sup>	4.620 <sup>BC</sup>	4.555
<b>Giza 51</b>	4.267 <sup>BC</sup>	5.067 <sup>B</sup>	3.460 <sup>C</sup>	4.980 <sup>B</sup>	4.622 <sup>B</sup>	4.780
<b>Sids Research Station</b>						
<b>Giza 4</b>	1.237 <sup>C</sup>	1.802 <sup>BC</sup>	1.622 <sup>BC</sup>	1.947 <sup>B</sup>	1.870 <sup>B</sup>	2.063
<b>Giza 51</b>	2.225 <sup>B</sup>	1.860 <sup>B</sup>	1.682 <sup>B</sup>	2.150 <sup>B</sup>	1.807 <sup>B</sup>	2.290
<b>Combined</b>						
<b>Giza station</b>	4.477 <sup>B</sup>	4.770 <sup>B</sup>	3.655 <sup>C</sup>	4.325 <sup>B</sup>	4.621 <sup>B</sup>	4.667
<b>Sids station</b>	1.731 <sup>BC</sup>	1.831 <sup>BC</sup>	1.652 <sup>C</sup>	2.049 <sup>B</sup>	1.839 <sup>BC</sup>	2.176
<b>Overall</b>	3.104 <sup>B</sup>	3.301 <sup>B</sup>	2.654 <sup>C</sup>	3.187 <sup>B</sup>	3.230 <sup>B</sup>	3.422

varieties, locations and their combined data are shown in Table (26).

The combined results in Table (26) revealed that all plant-sample sizes at Giza Research Station were significantly differed from the whole plot plants, while at Sids research station the values of pods/plant of 10, 30 and 50 plant showed no significant differences with the whole plot plants. These differences between Giza and Sids research stations reflected the presence of significant interaction of location x sample size. Concerning the overall data, the sample size of 30 plants had no significant difference with the whole plot- plant. Hence the optimum sample size for number of pods/plant was 30 plants.

The estimated value of phenotypic coefficient of variation (PCV) of pods/plant reached 45.70 % (Table 22). This value is close to the corresponding value of seed yield/plant, which was 54.87 %. In this regard, El-Attar (1991) reported that the optimum plant sample size for number of pods/plant in lentil was ranged from 20 to 40 plants. These results are agreed with our results.

### **B.3.5. Number of seeds per plant.**

There were significant differences among various plant sample sizes for number of seeds/plant as indicated by the combined analysis of variance presented in Table (18). In addition, the interactions of location x sample size and location x variety x sample size were also significant. The average performance of number of seeds/plant for the five sample sizes and the whole plot plants of the two varieties at Giza and Sids research stations as well as the average of sample sizes at Giza

Table (26). Average of no.of pods/plant for five sample sizes comparing with the whole plot plants of the two varieties Giza 4 and Giza 51 grown at Giza and Sids Research Stations and their combined data in 1999/2000 season.

Variety Location	Sample size (number of plants)				Whole plot plants	Average
	10	20	30	40		
<b>Giza Research Station</b>						
<b>Giza 4</b>	35.200 <sup>AB</sup>	36.675 <sup>A</sup>	28.300 <sup>C</sup>	29.075 <sup>BC</sup>	38.300 <sup>A</sup>	31.908
<b>Giza 51</b>	39.575 <sup>A</sup>	40.700 <sup>A</sup>	38.200 <sup>A</sup>	38.925 <sup>A</sup>	42.800 <sup>A</sup>	38.692
<b>Sids Research Station</b>						
<b>Giza 4</b>	8.175 <sup>C</sup>	9.675 <sup>BC</sup>	11.625 <sup>B</sup>	15.575 <sup>A</sup>	11.500 <sup>B</sup>	11.021
<b>Giza 51</b>	21.675 <sup>ABC</sup>	27.375 <sup>A</sup>	16.575 <sup>C</sup>	26.825 <sup>AB</sup>	23.400 <sup>ABC</sup>	22.708
<b>Combined</b>						
<b>Giza station</b>	37.388 <sup>AB</sup>	38.688 <sup>A</sup>	33.250 <sup>B</sup>	34.000 <sup>B</sup>	40.550 <sup>A</sup>	35.300
<b>Sids station</b>	14.925 <sup>C</sup>	18.525 <sup>AB</sup>	14.100 <sup>C</sup>	21.200 <sup>A</sup>	17.450 <sup>BC</sup>	16.865
<b>Overall</b>	26.156 <sup>BC</sup>	28.606 <sup>AB</sup>	23.675 <sup>CD</sup>	27.600 <sup>AB</sup>	29.000 <sup>A</sup>	26.082

and Sids and their combined overall data are given in Table (27).

The tabulated data showed that at Giza research station the sample sizes of 10, 20, 30 and 40 plants were not significantly differed from the whole plot plants (Table 27), while at Sids research Station the sample sizes that did not differed significantly from the whole plot plants were 30 and 50 plants. These differences between both locations reflecting the significant interaction effect of location x sample size.

The average performance of plant sample sizes overall varieties and locations revealed that the sample size of 30 plants was the only one which did not varied significantly from the whole plot plants. Therefore, this sample size considered the optimum sample to represent number of seeds/plant.

In this respect, **El-Attar (1991)** found that when grow lentil in narrow rows, plant samples consisted 10 or 40 plants are considered optimum sample size to measure seeds per plant, while when lentil planted in wide rows, sample size should be increased to be from 20 plants to more than 40 plants per sample.

Concerning variability of sample size of number of seeds/plant, the data in Table (22) showed that the phenotypic coefficient of variation of sample size of this character was 36.45 %, which was close to the corresponding value of number of pods/plant. Worthwhile, both characters of numbers of seeds and pods/plant showed the same optimum plant sample size of 30 plants.

Table (27). Average of no. of seeds/plant for five sample sizes comparing with the whole plot plants of the two varieties Giza 4 and Giza 51 grown at Giza and Sids Research Stations and their combined data in 1999/2000 season.

Variety	Sample size (number of plants)				Whole plot plants	Average
	10	20	30	40		
<b>Giza Research Station</b>						
<b>Giza 4</b>	51.325 <sup>AB</sup>	48.300 <sup>AB</sup>	38.375 <sup>B</sup>	40.675 <sup>AB</sup>	53.475 <sup>A</sup>	37.775 <sup>B</sup>
<b>Giza 51</b>	47.275 <sup>AB</sup>	47.300 <sup>AB</sup>	43.600 <sup>B</sup>	51.350 <sup>AB</sup>	56.175 <sup>A</sup>	48.200 <sup>AB</sup>
<b>Sids Research Station</b>						
<b>Giza 4</b>	20.775 <sup>AB</sup>	28.400 <sup>A</sup>	29.075 <sup>A</sup>	23.925 <sup>AB</sup>	19.575 <sup>BC</sup>	15.900 <sup>C</sup>
<b>Giza 51</b>	43.225 <sup>A</sup>	40.025 <sup>A</sup>	25.100 <sup>B</sup>	39.475 <sup>A</sup>	31.875 <sup>AB</sup>	31.225 <sup>AB</sup>
<b>Combined</b>						
<b>Giza station</b>	49.300 <sup>AB</sup>	47.800 <sup>AB</sup>	40.987 <sup>B</sup>	46.013 <sup>AB</sup>	54.825 <sup>A</sup>	42.987 <sup>B</sup>
<b>Sids station</b>	32.000 <sup>AB</sup>	34.213 <sup>A</sup>	27.088 <sup>BC</sup>	31.700 <sup>AB</sup>	25.725 <sup>BC</sup>	23.563 <sup>C</sup>
<b>Overall</b>	40.650 <sup>A</sup>	41.006 <sup>A</sup>	34.038 <sup>BC</sup>	38.856 <sup>AB</sup>	40.275 <sup>A</sup>	33.275 <sup>C</sup>

### **B.3.6. Plant height.**

The differences among various sample sizes of plant height character were significant as indicated in Table (18). But the three interaction variances of location x sample size, variety x sample size and location x variety x sample size were insignificant for this character. These results revealed that the sample size of plant height did not affected by varieties and/or location effects.

The average performances of plant height for various plant-sample sizes of varieties and locations and their combined data are shown in Table (28). The result presented in Table (28) showed that at Giza research station the plant-sample sizes had no significant differences between them and with the whole plot plants for both varieties. Similar trends were observed at Sids research station for both varieties, where no significant differences were occurred between various sample sizes and among them and the whole plot plants, except the sample size of 50 plants of Giza 51. These results reflected the absence of significant interaction of variety x sample size, location x sample size and location x variety x sample size as shown in Table (18).

The combined data in Table (28) showed similar results, where no significant difference among plant-sample sizes and between them and the whole plot plants were observed at both Giza and Sids research stations, except the 10 plants sample at Sids. The overall average of plant height for various sample sizes indicated also that no significant differences between sample sizes and the whole plot plants.

Table (28). Average of plant height (cm) for five sample sizes comparing with the whole plot plants of the two varieties Giza 4 and Giza 51 grown at Giza and Sids Research Stations and their combined data in 1999/2000 season.

Variety Location	Sample size (number of plants)				Whole plot plants	Average
	10	20	30	40		
<b>Giza Research Station</b>						
Giza 4	55.300 <sup>A</sup>	56.125 <sup>A</sup>	56.950 <sup>A</sup>	58.450 <sup>A</sup>	55.725 <sup>A</sup>	56.517
Giza 51	51.350 <sup>A</sup>	50.475 <sup>A</sup>	50.275 <sup>A</sup>	48.200 <sup>A</sup>	47.300 <sup>A</sup>	49.521
<b>Sids Research Station</b>						
Giza 4	50.925 <sup>A</sup>	46.625 <sup>A</sup>	48.025 <sup>A</sup>	48.500 <sup>A</sup>	47.975 <sup>A</sup>	48.408
Giza 51	52.600 <sup>A</sup>	46.775 <sup>BC</sup>	48.125 <sup>AB</sup>	48.575 <sup>AB</sup>	42.225 <sup>C</sup>	47.658
<b>Combined</b>						
Giza station	53.325 <sup>A</sup>	53.300 <sup>A</sup>	53.613 <sup>A</sup>	53.325 <sup>A</sup>	51.513 <sup>A</sup>	53.019
Sids station	51.763 <sup>A</sup>	46.700 <sup>B</sup>	48.075 <sup>B</sup>	48.538 <sup>AB</sup>	45.100 <sup>B</sup>	48.033
Overall	52.544 <sup>A</sup>	50.000 <sup>BC</sup>	50.844 <sup>AB</sup>	50.931 <sup>AB</sup>	48.306 <sup>C</sup>	50.526

The accumulated data of plant height suggesting that all plant-sample sizes are valid to measure plant height, but on the economic point of view, small sample size of 10 plants/sample considers the optimum size to represent the whole plot plants for plant height in lentil. Worthwhile, the phenotypic coefficient of variation of plant height was the lowest value among all characters and reached 10.94 % (Table 22).

### **B.3.7. Number of branches per plant.**

The analysis of variance in Table (18) revealed that no significant differences were obtained among sample sizes and also for the three interactions for number of branches/plant. These results are confirmed when comparing the averages of number of branches/plant for various sample sizes and the whole plot plants of both varieties and at both locations in Table (29).

The data in Table (29) showed that no significant differences were occurred between sample sizes and the whole plot plants in all cases, except 40 plants/sample of Giza 4 at Giza research station. These presented data suggesting that small sample size of 10 plants is considered the optimum to measure number of branches/plant in the present study. This finding was similar to those obtained for plant height. Also, number of branches/plant showed small value of phenotypic coefficient of variation of 25.44 as shown in Table (22). This value with the corresponding (PCV) value of plant height were the lowest values among all characters.

The above part presented the optimum plant-sample sizes for various characters. The sampling in experimental plot is important since plot size for field experiments is usually selected

branches/plant. While, biological and straw yield/plant characters should be estimated from the whole plot plants. These results are agreed with those previously reported in lentil by El-Attar (1991) who found that the optimum sample sizes for lentil characters were 20 plants for seed yield/plant, 20 plants for pods/plant and 40 plants for seeds/plant.

It seems that the characters, which had high variation, needed large sample size. As indicated above, it would be classified the studied characters into three groups. The first group consisted biological and straw yield/plant, which had the highest variation values (PCV %) of 76.86 % and 97.36 %, respectively. These characters should be estimated from the whole plot plants. The second group characters are seed yield/plant, number of pods/plant and number of seeds/plant. They showed moderate estimates of (PCV %) as 54.87 %, 45.70 % and 36.45 %, respectively, and they should be estimated from a sample size ranged from 20-30 plants. While the third group of characters was plant height and number of branches/plant, which exhibited the smallest values of (PCV %) of 10.94 % and 25.44 % and needed 10 plants/sample to be measured. These results are agreed with the finding of Nasr and El-Hady in faba bean (1998), who found that characters with high variation needed larger sample size to be measured and characters with low variation needed smaller sample size.

The obtained results indicated also that most studied characters, exhibited significant location x sample size interaction. Therefore, such studies should be carried out in various locations rather than in a single location to remove the location effect. Since the present investigation made at two

locations and the interpretation of the obtained results made on the overall data, so the presented results are valid to be used for recommendation.

As mentioned before, in previous study in lentil, significant interaction of plant density x sample size was reported (El-Attar, 1991). But since in the present study lentil experiments were planted with the recommended and common crop density so, the obtained results are also valid to be used for recommendation.