Nat. Volatiles & Essent. Oils, 2021; 8(5): 13251-13265

NVEO
Natural Volatiles &
Essential Oils

# Evaluation of Twenty Lentil Genotypes in Egypt

**M.M.F. Abdalla[1], M.M.H. Abd El-Wahab[1], E.K. Gendi[2], A. Hamdi[2]**

**and Huda Abdel- Salam[2]**

1- Agronomy Department, Faculty of Agriculture, Cairo University.
2- Food Legumes Res. Dept., Field crops Res. Institute, Agricultural Research Center (ARC), Giza, Egypt.

**ABSTRACT**

The present study aimed to evaluate twenty exotic and Egyptian lentil genotypes for all agronomic traits to determine the best genotypes to be exploited in Lentil Improvement Program at ARC. A two-year field experiment was conducted at three Agricultural Research Stations, ARC, Egypt, (1) Gemmiza in Gharbia Governorate in North Egypt, (2) Sids in Beni Sueif Governorate in Middle Egypt, and (3) Giza in Giza Governorate. The experiments were conducted during 2019/2020 and 2020/2021 winter seasons. The three lentil cultivars Giza 29, Giza 51 and Sinai 1 were used as local checks. The analysis of variance showed highly significant differences among genotypes, seasons and locations. The genotype Sinai 1 was the earliest in flowering (62.1 days) and maturity (123.2 days). Also, the new genotype: X2012-S-10 produced the tallest plants (42.5 cm). The Egyptian cultivar Giza 51 produces the largest no. of branches/plant (7.1). Nine new genotypes performed higher seed yield/faddan than the three local cultivars. These genotypes are: the mutant lines M10 and M52, and xG98-3-2, Flip81-17L, Flip 90-41L, Flip 96-46L, Flip 98-S-2600S, ILL2620 x ILL 9836 and X 2012-S-93. Their seed yield/faddan values ranged from 1025.3 to 1210.5 kg. These promising new genotypes in this study should be registered and using in lentil improvement programs.

**Key Words**: Lentil genotypes, Lens culinaris Medik.

## INTRODUCTION

Lentil (Lens culinaris Medik.) is among the important food legume crops in Egypt. It has a high nutritional value, as its seed is a rich source of protein, minerals (K, P, Fe, Zn) and vitamins for human nutrition **(Grusak 2010)**. Seed protein and mineral content are important quality characters in lentil. **(Hamdi et al 2002a)**. Moreover, lentil is also valuable of feed and fodder livestock **(Erskine et al 1990)** and plays an important role in crop rotations due to its nitrogen fixing capability **(Bremer et al 1988).**

The lentil breeding program at Food Legumes Research Department (FLRD) is built upon the foundation of the germplasm collection and their efficient use. It is well known that, the main objective in lentil or any plant breeding program is to utilize the available genotypes and breeding materials. Targeted and more efficient utilization of genotypes and breeding materials by plant breeders can be achieved if the trait characteristics of accessions are known

(**Furman et al 2010**). Therefore, evaluation of lentil accessions for key agronomic traits is important to enhance their potential for utilization.

Many studies on evaluation and estimation of genetic variability of lentil genotypes have been conducted nationally in Egypt and internationally all over the world. In Egypt, lentil genotypes have been evaluated early for qualitative and quantitative characters **(Hamdi and Ezatt 2000)**, for their response to rainfed condition **(Hamdi et al 1999)** and irrigation **(Hamdi and El-Assily (1995)**. Wide genetic and environment variation in seed yield and size, and cooking ability of Egyptian lentil accessions has been reported earlier by **Hamdi and Rabeia (1991).**

Development of high yielding lentil genotypes adapted to Egyptian agricultural conditions with good seed quality is one of the important factors to improve lentil production. The present study aimed to evaluate the exotic and new Egyptian lentil genotypes for key important agronomic traits to identify such traits and to determine the best genotypes to be exploited in lentil improvement programs.

**MATERIALS AND METHODS**

A total of 20 exotic and Egyptian lentil genotypes were used in this study (Table 1). They including eight exotic accessions introduced from ICARDA and widely varied in their pedigree, in addition to two genotypes developed by mutation breeding, and the wide spread Egyptian lentil cultivars "Giza 29, Giza 51 and Sinai1" as checks controls. The field experiments were conducted at three agricultural research stations of ARC, (1) Gemmiza in Gharbia Governorate in North Egypt, (2) Sids in Beni Sueif Governorate in Middle Egypt, and (3) Giza in Giza Governorate is very close to Cairo. The experiments were conducted during 2019/2020 and 2020/2021 winter seasons. Dates of planting were during 1-15 November 2019 and 2020 at all locations.

A randomized complete blocks design with three replications was used in each site. Each experimental plot contained two ridges (4 rows) 3-m long and 0.3-m apart (experimental plot area equals 1.8 $m^2$, with plant density of 300 plants/$m^2$. The following data were recorded: 1- Number of days to 50% flowering. 2- Number of days to 90% maturity. At maturity 10 guarded plants were taken at random from the central row in each experimental plot to measure the following characters:

3- Plant height (cm), 4- Number of branches/plant., 5- Number of pods/plant., 6- Number of seeds/plant., 7- Seed weight/plant (g). All the plants in each experimental plot were harvested by hand, then threshed, and the seeds were cleaned and then weighed to estimate seed yield/plot, which used to calculate seed yield/fadan (8).

Analysis of variance was made for every trait in each season and location according to **Gomez and Gomez (1984).**

Soil samples were collected from each location in 2019/2020 season only, and soil analysis was performed using the methods described by **Piper (1950) and Jakson (1973).** Several physical and chemical properties of location" soil are shown in Table (2).

The monthly maximum and minimum air temperatures during lentil growth period (November- April) at the three research stations in 2020/2021 season were recorded and presented in Table (3).

**Table 1. The name, origin and pedigree of the 20 lentil genotypes.**

| Genotype | Origin | Pedigree/characteristic |
|---|---|---|
| Flip 81- 17L (1) | ICARDA | Cross line introduced from ICARDA |
| Flip 95-51L (2) | ICARDA | Cross line introduced from ICARDA |
| Flip 95-59L (3) | ICARDA | Cross line introduced from ICARDA |
| XG 98-3-2 (4) | Egypt | Selection from hybrid line |
| X5-1 (5) | Egypt | Selection from hybrid line |
| X5-6 (6) | Egypt | Selection from hybrid line |
| M10 (7) | Egypt | mutant line |
| M52 (8) | Egypt | Mutant line |
| Flip 56-2L (9) | ICARDA | Cross line introduced from ICARDA |
| Flip 90-41L (10) | ICARDA | Cross line introduced from ICARDA |
| Flip 96-46L (11) | ICARDA | Cross line introduced from ICARDA |
| Flip 98-S-2600S (12) | ICARDA | Cross line introduced from ICARDA |
| ILL 7620 x ILL 9836 (13) | ICARDA | Cross line introduced from ICARDA |
| X2012-S-18 (14) | Egypt | Selection from hybrid line |
| X2012-S-59 (15) | Egypt | Selection from hybrid line |
| X2012-S-93 (16) | Egypt | Selection from hybrid line |
| X2012-S-210 (17) | Egypt | Selection from hybrid line |
| Sinai 1 (18) | Argentina | Selection from Precoz, early in maturity |
| Giza 51 (19) | Egypt | Released cultivar |
| Giza29 (20) | Egypt | Released cultivar |

**ICARDA: International Center for Agriculture Research in the Dry Areas.**

**Table 2. Mechanical and chemical analysis of the experimental soil at Giza, Gemmeiza and Sids in 2018/2019 season.**

| Property | Location | | |
|---|---|---|---|
| | Gemmeiza | Sids | Giza |
| **Mechanical analysis:** | | | |
| Coarse Sand%..... | 8.5 | 5.6 | 9.38 |
| Fine Sand%..... | 17.4 | 13.5 | 25.75 |
| Silt%..... | 36.5 | 39.0 | 35.80 |
| Clay%..... | 37.6 | 41.9 | 32.4 |
| Texture grad | Clay loam | Clay loam | Clay loam |
| E.C. ($dSm^{-1}$)..... | 2.7 | 2.5 | 2.1 |
| PH (soil aste)..... | 7.76 | 7.80 | 7.81 |
| Soluble cations ($mg^{-1}$) | | | |
| Ca..... | 6.40 | 7.50 | 4.22 |
| Mg..... | 3.8 | 4.0 | 2.88 |
| Na..... | 14.4 | 15.2 | 3.00 |
| K..... | 1.1 | 1.6 | 1.19 |
| P..... | | | |
| Soluble anion ($mg^{-1}$) | 10.5 | 12.3 | 8.4 |
| $HCO_3$..... | 1.1 | 4.4 | 3.28 |
| Cl..... | 17.6 | 21.6 | 4.33 |
| $SO_4$..... | 4.0 | 7.3 | 3.68 |
| DTPA- extractable ($mg\ Kg^{-1}$) | | | |
| Fe..... | 11.3 | 16.6 | 5.78 |
| Mn..... | 5.3 | 8.4 | 3.31 |
| Zn..... | 2.0 | 8.3 | 1.10 |
| Cu..... | 0.70 | 0.88 | 0.58 |

**Table 3. Monthly average maximum (Max) and minimum (Min) air temperature at Gemmeiza, Sids and Giza Research Stations in 2020/2021 season (November – April).**

| Location | | Nov. | Dec. | Jan. | Feb. | March | Abril | Mean |
|---|---|---|---|---|---|---|---|---|
| Gemmeiza | Max | 22.7 | 19.4 | 18.1 | 21.4 | 23.8 | 24.6 | 21.67 |
| | Min | 11.9 | 9.6 | 6.3 | 7.9 | 11.7 | 17.4 | 10.8 |
| Sids | Max | 28.39 | 24.7 | 21.92 | 23.32 | 29.6 | 29.9 | 26.21 |
| | Min | 12.26 | 12.22 | 12.12 | 12.41 | 12.45 | 12.39 | 10.64 |
| Giza | Max | 25.9 | 23.4 | 19.3 | 21.2 | 24.9 | 29.1 | 20.8 |
| | Min | 15.2 | 11.1 | 8.1 | 9.4 | 12.0 | 14.3 | 11.7 |

**RESULTS AND DISCUSSIO**

The overall means of all studied characters for all genotypes in two seasons and the three locations are presented in Table (13).

**Variation among locations:**

Average of all studied traits at the three locations are presented in Table (4). The soil analysis (Table 2) showed that the soil at Sids contained the highest percentage of silt and clay of 39.0 and 41.9 compared with 36.5 and 37.6 at Gemmeiza, and 35.8 and 32.4 at Giza. So the soil at Sids is more fertile than the soil at Gemmeiza and Giza.

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The average maximum air temperature during the growing season at Sids (26.1$^{o}$ C) was higher than the corresponding temperatures at Gemmeiza (21.7$^{o}$ C) and Giza (20.8$^{o}$ C) (Table 3).

**Table 4. Average of all studied traits at the three locations over lentil genotypes and seasons.**

| Trait | Gemmeiza | Sids | Giza |
|---|---|---|---|
| **Days to 50% flowering** | **67.85** | **73.15** | **90.5** |
| **Days to 90% maturity** | **133.00** | **139.15** | **141.2** |
| **Plant height (cm)** | **33.6** | **42.5** | **42.75** |
| **No. of branches plant$^{-1}$** | **4.65** | **6.65** | **5.6** |
| **No. of pods plant$^{-1}$** | **34.3** | **72.35** | **39.5** |
| **No. of seeds plant$^{-1}$** | **46.2** | **100.35** | **74.7** |
| **Seed yield plant$^{-1}$** | **1.1** | **2.6** | **1.9** |
| **Seed yield kg fad.$^{-1}$** | **508.8** | **1362.25** | **1088.6** |

The lentil genotypes grown at Sids were taller than those grown at Gemmeiza and Giza. Also, the lentil genotypes grown at Sids performed higher number of branches/plant, No. of pods/plant, No. of seeds/plant, seed yield/plant, and seed yield kg/faddan, than at Gemmeiza and Giza (Table 4). This may be due to that Sids had the highest maximum temperature, and more fertile soil, which gave good growth conditions to lentil genotypes.

**Days to 50% flowering and 90% maturity:**

The data of days to 50% flowering in Table (5) showed that No. of days from sowing to50% flowering at Gemmiza ranged from 57.5 days for Sinai 1 (18) to72.3 days for Flip 81-17L (1). Similarity at Sids No. of days from sowing to50% flowering ranged from 62.85 days for Sinai 1 (18) to 77.35 days for Flip 81-17L (1). The same trend was also at Giza, No. of days from sowing to50% flowering ranged from 65.85 days for Sinai 1 (18) to 91.5 days for Flip 81-17L (1). The

data of days to 90% maturity (Table 6) also presented the same trend, where No. of days from sowing to 90% maturity ranged from 118 days for Sinai 1 (18) to 134.85 days for Flip 81-17L (1) at Gemmiza, and ranged from 129.5 days for Sinai 1 to 143.65 days for x2012-S-93 (16) at Sids. Also at Giza, the cultivar Sinai1 was the earliest in maturity and matured at 122.15days, while the genotype x2012-S-93 (16) matured at 146.8 days. Earliness in flowering and maturity of Sinai1 was previously reported by **Hamdi et al (2002b).**

**Table 5. Means of No. of days to 50% flowering of all genotypes in two seasons and at three locations**

| Genotype | Gemmiza | | | Sids | | | Giza | | |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | Mean | S1 | S2 | Mean | S1 | S2 | Mean |
| 1 | 80.3 | 64.3 | 72.30 | 71.7 | 83.0 | 77.35 | 87.3 | 95.7 | 91.50 |
| 2 | 77.0 | 60.0 | 68.50 | 68.7 | 80.0 | 74.35 | 89.0 | 99.0 | 94.00 |
| 3 | 80.3 | 61.3 | 70.80 | 69.0 | 73.0 | 71.00 | 74.0 | 77.0 | 75.50 |
| 4 | 70.7 | 61.0 | 65.85 | 71.0 | 83.0 | 77.00 | 87.3 | 105.0 | 96.15 |
| 5 | 78.0 | 60.3 | 69.15 | 68.0 | 81.3 | 74.65 | 84.0 | 105.0 | 94.50 |
| 6 | 77.0 | 60.7 | 68.85 | 67.0 | 73.7 | 70.35 | 79.0 | 110.3 | 94.65 |
| 7 | 70.0 | 60.7 | 65.35 | 74.3 | 79.0 | 76.65 | 84.0 | 117.0 | 100.50 |
| 8 | 72.7 | 61.3 | 67.00 | 71.7 | 76.7 | 74.20 | 87.3 | 89.0 | 88.15 |
| 9 | 69.7 | 58.0 | 63.85 | 69.3 | 72.3 | 70.80 | 77.3 | 111.0 | 94.15 |
| 10 | 79.7 | 61.0 | 70.35 | 72.3 | 81.0 | 76.65 | 77.3 | 105.0 | 91.15 |
| 11 | 70.7 | 60.3 | 65.50 | 69.7 | 72.3 | 71.00 | 87.3 | 105.0 | 96.15 |
| 12 | 81.0 | 62.3 | 71.65 | 74.3 | 77.7 | 76.00 | 87.3 | 92.3 | 89.80 |
| 13 | 76.0 | 61.7 | 68.85 | 69.7 | 75.0 | 72.35 | 82.3 | 111.0 | 96.65 |
| 14 | 75.3 | 60.7 | 68.00 | 69.7 | 80.7 | 75.20 | 85.7 | 89.0 | 87.35 |
| 15 | 75.7 | 60.0 | 67.85 | 69.0 | 82.3 | 75.65 | 77.3 | 105.0 | 91.15 |
| 16 | 77.0 | 66.7 | 71.85 | 68.7 | 83.0 | 75.85 | 89.0 | 111.0 | 100.00 |
| 17 | 70.0 | 62.0 | 66.00 | 71.3 | 72.0 | 71.65 | 81.3 | 99.0 | 90.15 |
| 18 | 60.7 | 54.3 | 57.50 | 67.7 | 58.0 | 62.85 | 70.7 | 61.0 | 65.85 |
| 19 | 80.0 | 61.3 | 70.65 | 70.0 | 81.3 | 75.65 | 74.0 | 85.0 | 79.50 |
| 20 | 74.7 | 59.3 | 67.00 | 69.0 | 77.3 | 73.15 | 80.0 | 105.0 | 92.50 |
| Mean | 74.8 | 60.9 | 67.85 | 70.1 | 77.1 | 73.60 | 82.1 | 98.9 | 90.50 |
| LSD 0.05 | 3.126 | 3.538 | 2.32 | 2.804 | 2.833 | 73.6 | 5.465 | 14.82 | 7.764 |
| CV% | 5.53 | 3.52 | | 2.42 | 2.22 | 1.96 | 4.03 | 9.07 | |
| | | | | | | | | | |

**S1: 2019/2020, S2: 2020/2021**

**Table 6. Means of No. of days to 90% maturity of all genotypes in two seasons and at three locations.**

| Genotype | Gemmiza | | | Sids | | | Giza | | |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | Mean | S1 | S2 | Mean | S1 | S2 | Mean |
| 1 | 137.7 | 132.0 | 134.85 | 135.7 | 141.0 | 138.35 | 147.3 | 141.3 | 144.30 |
| 2 | 136.3 | 130.7 | 133.50 | 137.0 | 145.3 | 141.15 | 148.7 | 143.0 | 145.85 |
| 3 | 137.0 | 129.3 | 133.15 | 136.3 | 143.3 | 139.80 | 134.7 | 133.0 | 133.85 |
| 4 | 136.3 | 131.7 | 134.00 | 141.0 | 141.7 | 141.35 | 147.3 | 143.7 | 145.50 |
| 5 | 137.3 | 131.7 | 134.50 | 137.7 | 146.3 | 142.00 | 144.0 | 143.7 | 143.85 |
| 6 | 136.7 | 132.0 | 134.35 | 135.0 | 142.3 | 138.65 | 138.7 | 141.3 | 140.00 |
| 7 | 130.7 | 133.3 | 132.00 | 135.7 | 141.7 | 138.70 | 144.7 | 145.0 | 144.85 |
| 8 | 137.0 | 130.7 | 133.85 | 136.3 | 143.3 | 139.80 | 147.3 | 138.0 | 142.65 |
| 9 | 136.0 | 131.3 | 133.65 | 135.7 | 140.7 | 138.20 | 136.0 | 144.3 | 140.15 |
| 10 | 134.0 | 131.3 | 132.65 | 135.0 | 135.3 | 135.15 | 137.3 | 143.7 | 140.50 |
| 11 | 138.0 | 130.7 | 134.35 | 140.7 | 142.3 | 141.50 | 147.3 | 143.7 | 145.50 |
| 12 | 135.0 | 131.7 | 133.35 | 135.7 | 142.0 | 138.85 | 147.0 | 141.3 | 144.15 |
| 13 | 137.0 | 132.7 | 134.85 | 137.7 | 141.3 | 139.50 | 142.3 | 144.3 | 143.30 |
| 14 | 135.3 | 130.0 | 132.65 | 135.7 | 143.7 | 139.70 | 145.7 | 138.0 | 141.85 |
| 15 | 135.3 | 132.7 | 134.00 | 138.3 | 141.7 | 140.00 | 135.7 | 143.7 | 139.70 |
| 16 | 137.3 | 133.3 | 135.30 | 136.3 | 151.0 | 143.65 | 149.3 | 144.3 | 146.80 |
| 17 | 135.7 | 129.3 | 132.50 | 135.7 | 143.0 | 139.35 | 142.3 | 143.0 | 142.65 |
| 18 | 130.7 | 105.3 | 118.00 | 130.7 | 128.3 | 129.50 | 129.3 | 115.0 | 122.15 |
| 19 | 137.3 | 130.7 | 134.00 | 134.3 | 142.7 | 138.50 | 132.3 | 136.3 | 134.30 |
| 20 | 136.3 | 132.0 | 134.15 | 133.7 | 145.3 | 139.50 | 140.7 | 143.7 | 142.20 |
| Mean | 135.9 | 130.1 | 133.00 | 136.2 | 142.1 | 139.15 | 141.9 | 140.5 | 141.20 |
| LSD 0.05 | 2.319 | 1.647 | 0.23 | 2.255 | 2.575 | 1.68 | 7.627 | 2.493 | 3.944 |
| CV% | 1.03 | 0.77 | | 1.00 | 1.10 | | 3.25 | 1.07 | |

**S1: 2019/2020, S2: 2020/2021**

**Plant height and number of branches/plant:**

Significant differences between lentil genotypes in both plant height (Table7) and number of branches-plant (Table 8) throughout the seasons and locations' were occurred. The Egyptian cultivar Giza 51 performed the tallest plants at Gemmiza with 36.1cm, while at Sids the genotype Flip 81-17L (1) performed the tallest plants of 49.53cm. The new genotype X2012- S-59 (14) gave the highest No. of branches/plant with 6.05 at Gemmiza (Table 8). While at Sids and Giza, the Egyptian cultivar Giza 51 (19) gave the highest No. of branches/plant with 8.65, and 7.5, respectively.

**Table 7. Means of plant height (cm) of all genotypes in two seasons and at three locations.**

| Genotype | Gemmiza | | | Sids | | | Giza | | |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | Mean | S1 | S2 | Mean | S1 | S2 | Mean |
| 1 | 31.0 | 35.7 | 33.35 | 46.7 | 52.0 | 49.35 | 37.7 | 47.3 | 42.50 |
| 2 | 32.4 | 33.7 | 33.05 | 38.3 | 31.7 | 35.00 | 40.7 | 45.3 | 43.00 |
| 3 | 32.3 | 37.7 | 35.00 | 46.7 | 38.7 | 42.70 | 37.3 | 47.0 | 42.15 |
| 4 | 28.4 | 34.0 | 31.20 | 40.0 | 43.0 | 41.50 | 46.7 | 50.3 | 38.50 |
| 5 | 29.9 | 36.0 | 32.95 | 38.3 | 40.0 | 39.15 | 35.3 | 50.3 | 42.80 |
| 6 | 31.5 | 35.0 | 33.25 | 41.7 | 45.0 | 43.35 | 44.7 | 50.3 | 47.50 |
| 7 | 30.8 | 35.3 | 33.05 | 43.3 | 46.7 | 45.00 | 43.0 | 41.7 | 42.35 |
| 8 | 30.2 | 37.0 | 33.60 | 45.0 | 49.0 | 47.00 | 44.0 | 43.7 | 43.85 |
| 9 | 27.8 | 34.0 | 30.90 | 43.3 | 43.0 | 43.15 | 39.0 | 49.3 | 44.15 |
| 10 | 31.5 | 38.3 | 34.90 | 40.0 | 39.0 | 39.50 | 38.3 | 40.0 | 39.15 |
| 11 | 32.0 | 36.0 | 34.00 | 40.0 | 40.0 | 40.00 | 39.3 | 46.0 | 42.65 |
| 12 | 31.7 | 37.3 | 34.50 | 43.3 | 44.0 | 43.65 | 42.0 | 50.7 | 46.35 |
| 13 | 33.9 | 38.0 | 35.95 | 41.7 | 48.7 | 45.20 | 42.7 | 49.3 | 46.00 |
| 14 | 32.7 | 33.7 | 33.20 | 43.3 | 42.0 | 42.65 | 38.3 | 40.7 | 39.50 |
| 15 | 31.6 | 33.3 | 32.45 | 41.7 | 45.3 | 43.50 | 44.0 | 47.3 | 45.65 |
| 16 | 31.4 | 34.7 | 33.05 | 35.0 | 47.3 | 41.15 | 41.0 | 50.0 | 45.50 |
| 17 | 28.9 | 37.0 | 32.95 | 46.7 | 53.5 | 50.10 | 39.7 | 49.0 | 44.35 |
| 18 | 32.1 | 36.0 | 34.05 | 40.0 | 37.0 | 38.50 | 32.7 | 27.7 | 30.20 |
| 19 | 33.5 | 38.7 | 36.10 | 41.7 | 39.3 | 40.50 | 32.3 | 46.0 | 39.15 |
| 20 | 31.9 | 37.3 | 34.60 | 43.3 | 35.0 | 39.15 | 37.3 | 41.7 | 39.50 |
| Mean | 31.3 | 35.9 | 33.60 | 42.0 | 43.0 | 42.50 | 39.8 | 45.7 | 42.75 |
| LSD 0.05 | 3.270 | 1.740 | 1.82 | 3.371 | 2.057 | 3.76 | 6.500 | 3.574 | 3.646 |
| CV/ | 6.33 | 2.93 | | 10.62 | 2.89 | | 9.88 | 4.73 | |

**S1: 2019/2020, S2: 2020/2021**

**Table 8. Means of No. of branches/plant of all genotypes in two seasons and at three locations.**

| Genotype | Gemmiza | | | Sids | | | Giza | | |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | Mean | S1 | S2 | Mean | S1 | S2 | Mean |
| 1 | 5.0 | 3.5 | 4.25 | 3.6 | 8.5 | 7.05 | 3.7 | 6.7 | 5.20 |
| 2 | 5.9 | 3.8 | 4.85 | 3.6 | 7.9 | 5.75 | 4.9 | 6.9 | 5.90 |
| 3 | 7.5 | 4.3 | 5.90 | 4.3 | 9.4 | 6.85 | 4.0 | 5.6 | 4.80 |
| 4 | 6.0 | 3.0 | 4.50 | 4.0 | 8.9 | 6.45 | 3.1 | 8.8 | 5.95 |
| 5 | 5.4 | 3.2 | 4.30 | 5.6 | 6.0 | 5.80 | 3.3 | 8.1 | 5.70 |
| 6 | 7.8 | 4.1 | 5.95 | 4.4 | 7.3 | 5.85 | 4.2 | 9.3 | 6.75 |
| 7 | 6.2 | 2.8 | 4.50 | 4.0 | 10.0 | 7.00 | 4.0 | 8.8 | 6.40 |
| 8 | 4.6 | 3.9 | 4.25 | 5.0 | 8.3 | 6.65 | 3.7 | 4.5 | 4.10 |
| 9 | 4.4 | 4.3 | 4.35 | 4.7 | 9.7 | 7.20 | 3.4 | 8.3 | 5.85 |
| 10 | 4.7 | 3.5 | 4.10 | 5.2 | 7.6 | 6.40 | 4.1 | 5.9 | 5.00 |
| 11 | 4.8 | 2.6 | 3.70 | 5.0 | 6.6 | 5.80 | 3.5 | 5.7 | 4.60 |
| 12 | 4.7 | 3.0 | 3.85 | 4.6 | 8.8 | 6.70 | 3.6 | 6.1 | 4.85 |
| 13 | 5.3 | 3.9 | 4.60 | 3.7 | 8.1 | 5.90 | 8.4 | 8.9 | 8.65 |
| 14 | 8.6 | 3.5 | 6.05 | 4.1 | 8.5 | 6.30 | 3.5 | 8.2 | 5.85 |
| 15 | 6.0 | 3.1 | 4.55 | 4.8 | 9.7 | 7.25 | 3.7 | 5.7 | 4.70 |
| 16 | 5.8 | 3.2 | 4.50 | 5.0 | 9.8 | 7.40 | 7.1 | 6.1 | 6.60 |
| 17 | 6.4 | 4.2 | 5.30 | 4.3 | 8.6 | 6.45 | 4.5 | 4.3 | 4.40 |
| 18 | 4.6 | 3.4 | 4.00 | 5.7 | 6.9 | 6.30 | 3.8 | 5.5 | 4.65 |
| 19 | 6.2 | 4.0 | 5.10 | 6.8 | 10.5 | 8.65 | 4.2 | 10.8 | 7.50 |
| 20 | 4.7 | 3.8 | 4.25 | 5.0 | 9.9 | 7.45 | 4.8 | 4.3 | 4.55 |
| Mean | 5.7 | 3.6 | 4.65 | 4.8 | 8.5 | 6.65 | 4.3 | 6.9 | 5.60 |
| LSD 0.05 | 1.740 | 0.5750 | 0.895 | 1.438 | 0.6714 | 0.76 | 1.874 | 0.7318 | 0.989 |
| CV% | 18.39 | 9.76 | | 18.28 | 4.75 | | 26.59 | 6.35 | |

**S1: 2019/2020, S2: 2020/2021**

**Yield component traits:**

The yield component traits included No. of pods/plant, No. of seeds/plant, and seed weight/plant (Tables 9, 10, 11, 12 and 13). For No. of pods/plant, the location Sids in the two seasons performed the highest No. of pods/plant with 72.35 pods. Five new genotypes had higher no. of pods/plant than the three local check cultivars, ranging from 42.25 to 53.25 pods/plant.

**Table 9. Means of No. of pods/plant of all genotypes in two seasons and at three locations.**

| Genotype | Gemmiza | | | Sids | | | Giza | | |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | Mean | S1 | S2 | Mean | S1 | S2 | Mean |
| 1 | 37.9 | 31.5 | 34.70 | 87.7 | 66.6 | 77.15 | 30.7 | 67.6 | 49.15 |
| 2 | 31.1 | 29.4 | 30.25 | 41.3 | 48.9 | 45.10 | 32.8 | 30.3 | 31.55 |
| 3 | 55.9 | 37.0 | 46.45 | 83.1 | 69.5 | 76.30 | 26.3 | 22.7 | 24.50 |
| 4 | 45.7 | 39.1 | 42.40 | 103.0 | 102.8 | 102.90 | 28.2 | 58.9 | 43.55 |
| 5 | 34.6 | 19.4 | 27.00 | 123.6 | 49.1 | 86.35 | 26.4 | 41.6 | 34.00 |
| 6 | 65.5 | 19.0 | 42.25 | 54.9 | 86.9 | 70.90 | 52.1 | 44.6 | 48.35 |
| 7 | 35.7 | 29.9 | 32.80 | 50.0 | 45.1 | 47.55 | 32.7 | 70.9 | 51.80 |
| 8 | 31.6 | 39.3 | 35.45 | 74.6 | 53.3 | 63.95 | 43.6 | 29.7 | 36.65 |
| 9 | 30.8 | 31.0 | 30.90 | 85.0 | 85.7 | 85.35 | 35.8 | 46.8 | 41.30 |
| 10 | 22.8 | 34.3 | 28.55 | 82.9 | 36.4 | 59.65 | 32.9 | 66.5 | 49.70 |
| 11 | 35.3 | 16.7 | 26.00 | 88.6 | 91.9 | 90.25 | 20.0 | 49.0 | 34.50 |
| 12 | 34.7 | 27.4 | 31.05 | 60.2 | 62.9 | 61.55 | 46.4 | 58.9 | 52.65 |
| 13 | 39.7 | 28.3 | 34.00 | 74.4 | 66.3 | 70.35 | 66.9 | 52.3 | 59.60 |
| 14 | 75.3 | 31.2 | 53.25 | 54.0 | 83.3 | 68.65 | 23.0 | 30.4 | 26.70 |
| 15 | 44.2 | 27.2 | 35.70 | 87.5 | 81.9 | 84.70 | 22.9 | 40.7 | 31.80 |
| 16 | 40.4 | 20.4 | 30.40 | 91.2 | 78.7 | 84.95 | 37.8 | 37.3 | 37.55 |
| 17 | 45.7 | 42.8 | 44.25 | 70.8 | 90.5 | 80.65 | 24.7 | 32.8 | 28.75 |
| 18 | 24.2 | 11.8 | 18.00 | 70.2 | 36.8 | 53.50 | 21.7 | 24.4 | 23.05 |
| 19 | 27.9 | 27.6 | 27.75 | 86.6 | 62.3 | 74.45 | 29.9 | 72.2 | 51.05 |
| 20 | 29.9 | 41.0 | 35.45 | 52.4 | 72.1 | 62.25 | 27.1 | 40.6 | 33.85 |
| Mean | 39.4 | 29.2 | 34.30 | 76.1 | 68.6 | 72.35 | 33.1 | 45.9 | 39.50 |
| LSD 0.05 | 3.743 | 4.959 | 3.05 | 7.192 | 7.810 | 5.22 | 4.505 | 6.272 | 3.795 |
| CV% | 5.74 | 10.27 | | 5.72 | 6.88 | | 8.24 | 8.27 | |

**S1: 2019/2020, S2: 2020/2021**

**Table 10. Means of No. of seeds/plant of all genotypes in two seasons and at three locations.**

| Genotype | Gemmiza | | | Sids | | | Giza | | |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | Mean | S1 | S2 | Mean | S1 | S2 | Mean |
| 1 | 44.0 | 41.3 | 42.65 | 114.5 | 86.0 | 100.25 | 39.2 | 103.2 | 71.25 |
| 2 | 44.6 | 33.2 | 38.90 | 58.0 | 130.9 | 94.45 | 41.7 | 25.8 | 58.75 |
| 3 | 74.1 | 51.0 | 62.55 | 86.5 | 87.7 | 87.10 | 36.6 | 171.4 | 104.00 |
| 4 | 53.1 | 43.4 | 48.25 | 83.2 | 117.3 | 100.25 | 36.5 | 162.2 | 99.35 |
| 5 | 42.9 | 30.4 | 36.65 | 201.4 | 94.9 | 148.15 | 16.5 | 94.3 | 55.40 |
| 6 | 76.7 | 25.7 | 51.20 | 79.7 | 130.6 | 105.15 | 71.1 | 105.3 | 88.20 |
| 7 | 85.5 | 43.6 | 64.55 | 86.5 | 90.0 | 88.25 | 43.3 | 103.4 | 73.35 |
| 8 | 50.4 | 52.1 | 51.25 | 103.8 | 82.1 | 92.95 | 67.5 | 56.3 | 61.90 |
| 9 | 43.9 | 38.7 | 41.30 | 87.1 | 104.9 | 96.00 | 82.8 | 138.6 | 90.70 |
| 10 | 30.9 | 43.7 | 37.30 | 123.2 | 53.5 | 88.35 | 51.5 | 127.1 | 89.30 |
| 11 | 42.5 | 34.5 | 38.50 | 186.4 | 94.9 | 140.65 | 39.5 | 117.1 | 78.30 |
| 12 | 45.1 | 38.0 | 41.55 | 48.8 | 98.0 | 73.40 | 52.0 | 120.2 | 86.10 |
| 13 | 56.8 | 41.2 | 49.00 | 88.7 | 110.7 | 99.70 | 70.9 | 117.9 | 94.40 |
| 14 | 115.1 | 37.7 | 76.40 | 67.3 | 108.0 | 87.65 | 32.3 | 92.4 | 62.35 |
| 15 | 56.7 | 29.6 | 43.15 | 126.7 | 87.8 | 107.25 | 38.1 | 88.5 | 63.30 |
| 16 | 55.5 | 33.6 | 44.55 | 176.5 | 144.9 | 160.70 | 90.9 | 135.7 | 113.30 |
| 17 | 48.0 | 56.6 | 52.30 | 144.8 | 64.7 | 104.75 | 32.2 | 45.9 | 39.05 |
| 18 | 35.3 | 8.3 | 21.80 | 75.7 | 58.4 | 67.05 | 21.3 | 37.1 | 29.20 |
| 19 | 32.9 | 53.1 | 43.00 | 117.5 | 58.2 | 87.85 | 34.9 | 126.5 | 80.70 |
| 20 | 40.9 | 38.0 | 39.45 | 84.7 | 68.8 | 76.75 | 51.2 | 59.7 | 55.45 |
| Mean | 53.7 | 38.7 | 46.20 | 107.1 | 93.6 | 100.35 | 45.5 | 103.9 | 74.70 |
| LSD 0.05 | 14.09 | 10.51 | 8.64 | 14.62 | 8.437 | 8.299 | 14.96 | 46.48 | 19.45 |
| CV/ | 15.86 | 16.44 | | 8.26 | 5.45 | | 19.90 | 28.76 | |

**S1: 2019/2020, S2: 2020/2021**

**Table 11. Means of seed weight (g)/plant of all genotypes in two seasons and at three locations.**

| Genotype | Gemmiza | | | Sids | | | Giza | | |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | Mean | S1 | S2 | Mean | S1 | S2 | Mean |
| 1 | 1.1 | 1.1 | 1.10 | 2.4 | 3.3 | 2.85 | 0.9 | 3.9 | 2.40 |
| 2 | 1.1 | 0.9 | 1.00 | 0.7 | 3.4 | 2.05 | 1.0 | 1.9 | 1.45 |
| 3 | 2.1 | 1.2 | 1.65 | 2.1 | 2.9 | 2.50 | 0.5 | 2.7 | 1.60 |
| 4 | 1.1 | 1.1 | 1.10 | 2.2 | 3.0 | 2.60 | 0.9 | 4.5 | 2.70 |
| 5 | 1.1 | 0.5 | 0.80 | 3.4 | 2.0 | 2.70 | 0.4 | 2.1 | 1.25 |
| 6 | 1.9 | 0.6 | 1.25 | 1.5 | 3.9 | 2.70 | 1.1 | 2.5 | 1.80 |
| 7 | 1.5 | 0.9 | 1.20 | 1.9 | 2.5 | 2.20 | 0.8 | 4.3 | 2.55 |
| 8 | 1.2 | 1.0 | 1.10 | 2.1 | 4.1 | 3.10 | 1.3 | 1.4 | 1.64 |
| 9 | 0.9 | 0.9 | 0.90 | 1.6 | 3.7 | 2.65 | 2.2 | 3.1 | 2.65 |
| 10 | 0.7 | 1.2 | 0.95 | 2.6 | 1.6 | 2.10 | 1.3 | 3.4 | 2.35 |
| 11 | 0.8 | 0.8 | 0.80 | 3.8 | 4.4 | 4.10 | 0.7 | 2.4 | 1.55 |
| 12 | 1.2 | 1.0 | 1.10 | 0.7 | 2.9 | 1.80 | 1.0 | 5.3 | 3.15 |
| 13 | 1.4 | 0.9 | 1.15 | 1.7 | 3.0 | 2.35 | 1.3 | 3.1 | 2.20 |
| 14 | 2.2 | 0.8 | 1.50 | 1.6 | 3.5 | 2.55 | 0.8 | 2.3 | 1.55 |
| 15 | 1.2 | 0.6 | 0.90 | 1.7 | 3.3 | 2.50 | 0.6 | 2.5 | 1.55 |
| 16 | 2.3 | 0.6 | 1.45 | 2.5 | 2.5 | 2.50 | 1.5 | 3.1 | 2.30 |
| 17 | 0.9 | 1.1 | 1.00 | 2.2 | 1.4 | 1.80 | 0.8 | 1.1 | 0.95 |
| 18 | 0.7 | 0.2 | 0.45 | 1.9 | 5.6 | 3.75 | 0.5 | 1.4 | 0.95 |
| 19 | 0.8 | 1.2 | 1.00 | 2.5 | 4.2 | 3.35 | 0.9 | 3.0 | 1.95 |
| 20 | 0.9 | 0.9 | 0.90 | 1.5 | 2.6 | 2.05 | 0.9 | 1.7 | 1.30 |
| Mean | 1.3 | 0.9 | 1.10 | 2.0 | 3.2 | 2.60 | 1.0 | 2.8 | 1.90 |
| LSD 0.05 | 0.5532 | 0.2507 | 0.299 | 0.6508 | 0.6549 | 0.454 | 0.5797 | 0.5630 | 0.0796 |
| CV% | 26.56 | 17.53 | | 19.38 | 12.40 | | 36.41 | 12.21 | |

**S1: 2019/2020, S2: 2020/2021**

**Table 12. Means of seed yield (kg)/faddan of all genotypes in two seasons and at three locations.**

| Genotype | Gemmiza | | | Sids | | | Giza | | |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | Mean | S1 | S2 | Mean | S1 | S2 | Mean |
| 1 | 343 | 793 | 568.2 | 1421 | 1486 | 1453.3 | 1139 | 1325 | 1232.2 |
| 2 | 406 | 653 | 529.7 | 988 | 1443 | 1215.4 | 700 | 1064 | 882.0 |
| 3 | 319 | 451 | 385.1 | 1631 | 1361 | 1496.1 | 966 | 1129 | 1047.7 |
| 4 | 368 | 677 | 522.4 | 1750 | 1538 | 1644.1 | 1008 | 1092 | 1050.0 |
| 5 | 374 | 443 | 408.7 | 1435 | 1307 | 1370.9 | 910 | 1241 | 1075.7 |
| 6 | 396 | 420 | 408.0 | 1038 | 1493 | 1265.7 | 1092 | 1372 | 1232.0 |
| 7 | 319 | 754 | 536.7 | 1363 | 1316 | 1339.7 | 1036 | 1363 | 1199.4 |
| 8 | 561 | 625 | 592.8 | 1447 | 1433 | 1440.1 | 1307 | 1017 | 1162.2 |
| 9 | 400 | 544 | 472.2 | 1357 | 1202 | 1279.4 | 747 | 1185 | 966.2 |
| 10 | 377 | 1182 | 779.6 | 1456 | 1367 | 1411.5 | 1008 | 1036 | 1022.0 |
| 11 | 433 | 953 | 692.9 | 1746 | 1219 | 1482.6 | 1302 | 1610 | 1456.0 |
| 12 | 581 | 681 | 630.8 | 1524 | 1427 | 1475.6 | 1185 | 1120 | 1152.5 |
| 13 | 473 | 587 | 530.1 | 1556 | 1386 | 1471.2 | 1400 | 1288 | 1344.0 |
| 14 | 408 | 451 | 429.6 | 1425 | 1324 | 1374.6 | 971 | 980 | 975.5 |
| 15 | 360 | 463 | 411.4 | 1159 | 1394 | 1276.6 | 1092 | 1185 | 1138.7 |
| 16 | 566 | 572 | 568.9 | 1180 | 1777 | 1478.6 | 1157 | 1027 | 1091.9 |
| 17 | 330 | 350 | 340.0 | 1330 | 1318 | 1324.2 | 765 | 1773 | 1269.2 |
| 18 | 366 | 156 | 260.8 | 768 | 760 | 764.2 | 420 | 756 | 588.0 |
| 19 | 442 | 657 | 549.6 | 1066 | 1696 | 1380.8 | 826 | 1213 | 1019.7 |
| 20 | 486 | 634 | 560.0 | 1398 | 1202 | 1299.9 | 616 | 1120 | 868.0 |
| Mean | 415 | 602 | 508.8 | 1352 | 1373 | 1362.3 | 982 | 1195 | 1088.6 |
| LSD 0.05 | 0.5532 | 0.2507 | 111.796 | 357.9 | 2.833 | 194.21 | 246.3 | 206.1 | 157.85 |
| CV% | 26.56 | 17.53 | | 16.02 | 2.22 | | 15.17 | 1.43 | |

**S1: 2019/2020, S2: 2020/2021**

**Table 13. The overall means of all studied characters for all genotypes in two seasons and the three locations.**

| Genotype | FL | Mat | Plht | Branch | Pods | Seeds | Sw/pl | Sy/F. |
|---|---|---|---|---|---|---|---|---|
| 1 | 80.4 | 139.2 | 41.7 | 5.5 | 53.7 | 71.4 | 2.1 | 1084.5 |
| 2 | 79.0 | 140.2 | 37.0 | 5.5 | 35.6 | 64.0 | 1.5 | 875.7 |
| 3 | 72.4 | 135.6 | 40.0 | 5.9 | 49.1 | 84.6 | 1.9 | 976.3 |
| 4 | 79.7 | 14.3 | 40.4 | 5.6 | 63.0 | 82.6 | 2.1 | 1072.1 |
| 5 | 79.4 | 140.1 | 38.3 | 5.3 | 49.1 | 80.1 | 1.6 | 951.7 |
| 6 | 78.0 | 137.7 | 41.4 | 6.2 | 53.8 | 81.5 | 1.9 | 968.6 |
| 7 | 80.8 | 138.5 | 40.1 | 6.0 | 44.1 | 75.4 | 2.0 | 1025.3 |
| 8 | 76.5 | 138.8 | 41.5 | 5.0 | 45.4 | 68.7 | 1.9 | 1065.0 |
| 9 | 76.3 | 137.3 | 39.4 | 5.8 | 52.5 | 76.0 | 2.1 | 905.9 |
| 10 | 79.4 | 136.1 | 37.9 | 5.2 | 46.0 | 71.7 | 1.8 | 1071.0 |
| 11 | 77.6 | 140.5 | 38.9 | 4.7 | 50.3 | 85.8 | 2.2 | 1210.5 |
| 12 | 79.2 | 138.8 | 41.5 | 5.1 | 48.4 | 67.0 | 2.0 | 1086.3 |
| 13 | 79.3 | 139.2 | 42.4 | 6.4 | 54.7 | 81.0 | 1.9 | 1115.1 |
| 14 | 76.9 | 138.1 | 38.5 | 6.1 | 49.5 | 75.5 | 1.9 | 926.6 |
| 15 | 78.2 | 137.9 | 40.5 | 5.5 | 50.7 | 71.2 | 1.7 | 942.2 |
| 16 | 82.6 | 141.9 | 39.9 | 6.2 | 51.0 | 106.2 | 2.1 | 1064.4 |
| 17 | 75.9 | 138.2 | 42.5 | 5.4 | 51.2 | 65.4 | 1.3 | 977.8 |
| 18 | 62.1 | 123.2 | 34.3 | 5.0 | 31.5 | 39.4 | 1.7 | 537.7 |
| 19 | 25.3 | 135.6 | 38.6 | 7.1 | 51.1 | 70.5 | 2.1 | 983.4 |
| 20 | 77.6 | 138.6 | 37.8 | 5.4 | 43.9 | 57.2 | 1.4 | 909.3 |
| Mean | 77.3 | 137.8 | 39.6 | 6.6 | 48.7 | 73.8 | 1.9 | 986.6 |

**FL: days to 50 flowering, Mat: days to 90 maturity, Pl ht: plant height (cm), Branch: No. of branches/plant, Pods: No. of pods/plant, Seeds: No. of seeds/plant, Sw/pl: seed weight/plant (g), seed yield/faddan (Kg).**

For No. of seeds/plant (Table 10), Also Sids location showed the highest No. of seeds/plant with 100.35 seeds, followd by Giza location (74.7 seeds/plant), and then Gemmiza location (46.2 seeds/plant). At Gemmiza, the new lentil genotypes: Flip 95-59L, X2012-S-18, and the mutant line M10 performed the highest No. of seeds/plant, which were: 62.55, 76.4, and 64.55, respectively. At Sids, eight new genotypes performed the highest No. of seeds/plant, which ranged from: 100.25 to 160.7. While at Giza, the new genotype: X2012-S-93 performed the highest No. of seeds/plant of 113.3 seeds. Data of seed weight/plant (Table 11) showed that Sids gave the highest mean of seed yield/plant of 2.6 g. Also at Sids, the Egyptian cultivars Sinai1 and Giza 51 gave the highest seed yield/plant of 3.75 and 3.35 g., respectively.

For seed yield/faddan: The overall mean of seed yield/faddan was 986.6 kg (Table 13). The two locations Sids and Giza gave the highest seed yields/faddan of 1362.25 and 1088.6 kg/faddan (Table 12). The overall mean of seed yield /fadan of the three local check cultivars Sinai1, Giza 51 and Giza 29 were 537.7, 983.4, and 909.3 kg, respectively (Table 13). In contrast, nine new genotypes performed higher seed yield/faddan than the three local

cultivars. These genotypes are: the mutant lines M10 and M52, and xG98-3-2, Flip81-17L, Flip 90-41L, Flip 96-46L, Flip 98-S-2600S, ILL2620 x ILL 9836 and X 2012-S-93. Their seed yield/faddan values ranged from 1025.3 to 1210.5 kg.

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