# EVALUATION OF SOME LENTIL GENOTYPES FOR EARLINESS, YIELD, YIELD COMPONENTS AND SEED QUALITY

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**Abstract**

The study aimed to evaluate 30 exotic and Egyptian lentil genotypes for earliness, yield, yield components, seed protein content, hydration coefficient before and after cooking, total soluble solids and seed cookability characters. Correlation and factor analysis procedures were used to determine the contributing characters in yield variation. The field trials were carried out at Giza Research Station in 2001/2002 and 2002/2003 seasons.

Genotypes FLIP 88-42L, PKVL-1, FLIP 96-52L, FLIP 97-30L, FLIP 97-33L and Sinai 1 were the earliest in flowering and maturity. FLIP 88-34L had the highest number of pods and seeds/plant and hence produced the highest seed yield/fed recording 4.10 ardab, surpassing Giza 9 by 35 %. This genotype also showed the highest rate of seed yield formation $d^{-1}$ of crop cycle.

Average seed protein content was 22.1 %. Eight genotypes had protein content above average ranged from 23.5 to 25.5 %. Amongest, the new released variety Giza 51 had 25 % seed protein content. Most genotypes gave high percentages of cookability above 85 %.

Significant and positive associations were detected between seed weight/plant and each of plant height, number of branches, pods and seeds/plant and weight of 100 seeds. Factor analysis grouped seven yield contributing characters into two main factors accounting for 74.13 % of the total variability in the dependence structure. Factor 1 was responsible for 42.66 % of the total variation and contained plant height, number of branches, pods and seeds/plant. Factor II included number of days to 50 % flowering and maturity and weight of 100 seeds and contributed 31.47 % of the total variability.

## INTRODUCTION

Lentil (*Lens culinaris Medikus*) is one of the most important food legumes in Egypt being a good source of protein (20-30 %) and carbohydrates (60-71 %), Hamdi and El-Emery (1996), and fairly a good source of thiamin, niacin, calcium and iron. The cultivated area of lentil in Egypt has declined drastically since 1980, reaching about 5000 feddan in 2001 and the total lentil production is still below the country requirements. Increasing lentil production is one of the major targets of the agricultural policy that can be achieved by increasing both lentil cultivated area and productivity. The lentil area can be expanded in reclaimed lands under rainfed conditions outside the Nile Valley and by planting lentil as a catch crop before cotton in the old land (Hamdi and Ezzat, 1998). Therefore, early maturing-short duration lentil varieties should be available to achieve this goal. Earliness is important since drought escape is the main mechanism for drought resistance in lentil. Hence, earliness is an important trait among selection criteria used in variety development.

Correlation studies between agronomic traits such as yield and its components would help plant breeders and agronomists to enhance crop growth and yield attributes (Ezzat and Ashmawy, 1999).

Determining the most important contributing characters to the total variability of yield is of major importance to successfully achieve a breeding strategy to develop high yielding genotypes of a given crop. Walton (1972) criticized some statistical procedures (multiple regression in both full model and stepwise as well as standard partial regression known as path coefficient) and mentioned that biologists must seek for right assistance from statistical methodology. He recommended factor analysis as a type of multivariate technique. Factor analysis reduces a large number of correlated variables to a small number of main factors, and is used as an approach to determine characters related to yield. This technique has been used in faba bean by Ashmawy *et al.*(1998).

The objectives of the study were to: 1- evaluate some exotic and local lentil genotypes to identify early maturing-high yielding genotypes with high protein content adapted to Egyptian conditions, 2- study the variability of lentil genotypes with respect to the important characters, and, 3- use factor analysis procedure to assist the dependent relationships between yield and yield components in lentil, which would be helpful to plan appropriate selection strategies.

## MATERIALS AND METHODS

A total of 30 exotic and Egyptian lentil genotypes were used in this study (Table 1). The exotic materials were received from the International Center for Agricultural Research in the Dry Areas (ICARDA). The wide spread Egyptian variety Giza 9 was used as a check. Accessions were grown at Giza Agricultural Research Station, ARC, Egypt during 2001/2002 and 2002/2003 winter seasons in a randomized complete block design with three replications. Each plot consisted of 4 rows 3.5 m long and 30 cm apart with plot area of 4.2 $m^2$.

Sowing was done on 16th and 19th November in the first and second seasons, respectively. Fertilizer was applied at the rate of 30 kg $P_2O_5$ and 15 kg N/fed prior to planting. Cultural practices were maintained at optimum levels for maximum lentil productivity. At maturity, lentil plants in the central 3 $m^2$ in each experimental plot were hand harvested, while the remaining plot area was discarded to avoid border effect.

**Studied characters:**

**A- Earliness:**

Days from planting to first flower, 50 % flowering, 100 % flowering, 50 % podding, 100 % podding and to 95 % maturity were recorded on plot basis.

**B- Growth and yield components:**

At harvest, a random sample of 10 guarded plants was collected from the central 3 $m^2$ in each plot to record characters of plant height, number of branches, pods, seeds and seed weight/plant. Seed yield/fed, crop efficiency (kg seed produced $d^{-1}$ of crop duration) and 100-seed weight were determined on plot basis.

**C- Seed quality:**

1- Seed protein content obtained by multiplying the total seed nitrogen % by 6.25 according to the method of A. O. A. C. (1990).
2- Seed hydration coefficient before cooking (H.C.B): 10 g of dry seeds from each experimental plot were soaked in tap water for 8 hrs, then H. C. B. was calculated as [( Weight of soaked seeds – weight of dry seeds)/weight of dry seeds] X 100.
3- Seed hydration coefficient after cooking (H.C.A): was calculated by placing 10 g of dry seeds from each experimental plot in 100 $cm^3$ glass tube containing enough water. The tubes were put in an oven for 2 hrs at 100° C. The Hydration coefficient after cooking (H.C.A.) was determined in cooked seeds according to the method of Fahmy *et al.* (1996) as H.C.A % = [(weight of cooked seeds – weight of dry seeds) / weight of dry seeds] X 100.
4- The total soluble solids (T. S. S %) was determined in (3) above by drying at 60 °C over night. T.S.S % was calculated as T.S.S = [(weight drying – weight of empty pot) / initial weight] X 100.
5- Seed cookability percentage (cook %): The ability of cooked seeds was measured by using the normal press of fingers and comparing between the cooked seeds for their hardness, which means the maximum force throughout their test. The cooking percentage was determined according to Selim (2000).

Table 1. Origin and pedigree of studied lentil genotypes.

| Genotypes | Origin | Pedigree |
|---|---|---|
| 1- FLIP 86 – 2L | ICARDA | ILL 466 X ILL 212 |
| 2- FLIP 87 – 21L | ICARDA | ILL 4349 X ILL 4605 |
| 3- Pant L 406 | India | Land race |
| 4- FLIP 87 – 70L | ICARDA | ILL 526 X ILL 253 |
| 5- FLIP 88 – 7L | ICARDA | ILL 5582 X SH 901 |
| 6- FLIP 88 - 42L | ICARDA | ILL 4605 X ILL 5506 |
| 7- L E N 8830 | ICARDA | LEN 8830 |
| 8- XG 88 – 16 | Egypt | Selection from hybrid line |
| 9- FLIP 97 – 13L | ICARDA | ILL 5700 X ILL 5722 |
| 10- FLIP 98 – 7 L | ICARDA | ILL 6245 X ILL 1939 |
| 11- PKVL –1 | India | ILL 7558 |
| 12- FLIP 92 – 48L | ICARDA | ILL 5583 X ILL 5724 |
| 13- FLIP 93 – 1L | ICARDA | ILL 5588 X ILL 5883 |
| 14- FLIP 95 – 1L | ICARDA | ILL 7657 |
| 15- FLIP 95 – 11L | ICARDA | ILL 5746 X ILL 5700 |
| 16- FLIP 96 – 18L | ICARDA | ILL 6245 X ILL 5883 |
| 17- FLIP 96 – 52L | ICARDA | ILL 298 X ILL 4605 |
| 18- FLIP 2001 – 3L | ICARDA | ILL 5883 X ILL 6999 |
| 19- FLIP 97 – 30L | ICARDA | UJ 88286L X ILL 6205 |
| 20- FLIP 97 – 33L | ICARDA | ILL 6471 X ILL 4404 |
| 21- XG98 – 13 | Egypt | Selection from hybrid line |
| 22- FLIP 2000 – 4L | ICARDA | ILL 5588 X ILL 6451 |
| 23- FLIP 2001 – 5L | ICARDA | ILL 6980 X ILL 5883 |
| 24- FLIP 88 – 34L | ICARDA | ILL 5584 X ILL 2501 |
| 25-Line(Fam300Xprecoz) | Egypt | Family 300 X precoz |
| 26- Family 29 | Egypt | Landrace |
| 27- ILL 590 | Turkey | ILL 590 |
| 28- Giza 9 | Egypt | Wide spread cultivar |
| 29- Giza 51 | ICARDA | Selection from Flip84-51L |
| 30- Sinai 1 | Argentina | Selection from precoz |

**Statistical procedures:**

**1-Analysis of variance:**

A combined analysis of variance of randomized complete block design over 2001/2002 and 2002/2003 seasons was performed according to Snedecor and Cochran (1980). Duncan's multiple range test was used to detect the significant differences between treatment means.

**2- Correlation analysis:**

Simple correlation coefficients were computed among seed weight/plant and its components and seed quality characters.

**3- Factor analysis:**

The factor analysis procedure basically reduces a large number of correlated variables to a small number of uncorrelated factors, Cattle (1965). When the contribution of a factor to the total percentage of the trace is less than 10 %, the process stops. After extraction, the matrix of factors is transmitted to a varimax orthogonal rotation, as applied by Kaiser (1958). The effect of rotation is to accentuate the larger loading in each factor and to prevent the minor loading coefficient for improving the opportunity to achieve a meaningful biological interpretation of each factor. A communality ($h^2$) is the variance amount of a variable accounted for the common factors together. Since the purpose was to determine the way in which yield components are related to each other, yield was not included in this structure. Factor analysis was performed using SPSS computer statistical package.

Correlation and factor analysis techniques were applied to the means of both seasons for characters of number of days to 50 % flowering and maturity, plant height, number of branches, pods and seeds/plant, weight of 100 seeds and seed weight/plant as well as seed quality characters.

## RESULTS AND DISCUSSION

Combined analysis of variance over the two seasons revealed significant differences between genotypes for all studied characters indicating wide genetic variation among genotypes.

**1-Eearliness:**

Means of earliness are presented in Table 2. Average number of days to first, 50 % and 100 % flowering were 66, 73 and 80.5 days, respectively. A wide range of variation existed in these characters. Six genotypes namely: PKVL-1, FLIP 88-42L, FLIP 96-52L, FLIP 97-30L, FLIP 97-33L and Sinai 1 were the earliest in first, 50 and 100 % flowering. These promising genotypes were earlier than Giza 9 (the check) by 32.2, 32.2, 30.7, 30.2, 30.2 and 28 days, respectively.

Results revealed that the averages of 50 and 100 % podding were 93.9 and 105.3 days, respectively. Plants of PKVL-1 were the earliest to start podding with an average of 74.2 days for 50 % podding and 81.8 days for 100 % podding followed by FLIP 96-52L and FLIP 97-30L, respectively.

The overall mean of days to 95 % maturity was 141.2 days with a range of 124 -156.5 days. Six genotypes: FLIP 88-42L, PKVL-1, Sinai I, FLIP 97-30L, FLIP 97-33L and FLIP 96-52L were the earliest in maturity as they matured at 124, 124.8, 125, 126, 126 and 129 days, respectively, after sowing. Moreover, these promising genotypes were significantly earlier than local check Giza 9 by 20.0, 19.2, 19.0, 18.0, 18.0 and 15.0 days, respectively. It is worth noting that these genotypes were among the earliest flowering genotypes and hence they deserve further testing.

Regarding the relationships among earliness characters, there were strong positive correlations between 95 % maturity and each of days to first, 50 and 100 % flowering, 50 and 100 % podding (r ranged from $0.81^{**}$ to $0.85^{**}$). These results indicate that in future studies in lentil, selection for earliness, recording number of days to maturity, is sufficient to identify earliness in flowering and podding. Ibrahim (2001) also mentioned that measuring only one earliness trait which is strongly correlated with other earliness characters is sufficient for indicating earliness and saves time and cost.

**2- Yield and yield components:**

The combined results of yield and its components over seasons are shown in Table 3. The results revealed significant differences among genotypes for all studied characters.

Results showed wide variation in plant height from 24.6 to 51.5 cm. Plants of the highest yielding genotypes were significantly taller than those of the check cultivar Giza 9. Therefore, these genotypes appear more suitable for mechanical harvesting. There was a significant variation among studied genotypes in total number of branches/plant from 6.87 to 15.20. Plant height and number of branches/plant are important characters since they reflect plant vigor, which leads to high yield and their variability would be helpful for selecting parents to be used in crossing programs. These results are in harmony with those reported by Hamdi and Ezzat 1998, Ezzat and Ashmawy (1999), Selim (2000), Ibrahim (2001) and Hamdi *et al.* (2003) who observed wide variability in plant height and number of branches/plant in lentil.

Results in Table 3 also show that both number of pods and seeds/plant varied widely among the tested genotypes. Averages of both characters were 28.5 and 38.4, respectively. Number of pods/plant ranged from 9.7 to 73.5 and number of seeds/plant ranged from 12.9 to 87.7. FLIP 88-34L produced the highest number of pods and seeds/plant being 73.5 and 87.7 followed by Line (Family 300 X precoz) (70.0 and 83.7), XG 98-13 (69.6 and 84.0) and Family 29 (55.7 and 70.4). These genotypes surpassed the local check Giza 9 which produced 45.0 and 57.0, pods and seeds/plant, respectively.

Results indicated also that there was wide variation in seed weight/plant. Three genotypes: FLIP 88-34L, Line (Family 300 X precoz) and X G98-13 gave the maximum seed weight/plant recording 2.56, 2.38 and 2.25 g, respectively. These genotypes outyielded the check cultivar Giza 9 by 100.02, 87.40 and 77.17 %, respectively.

Weight of 100 seeds was ranging between 1.47- 4.92 g with an overall average of 2.82 g, indicating that most of the tested genotypes are small seeded. In comparison, the average 100-seed weight of international lentil germplasm at ICARDA is 3.4 g, Hamdi *et al.* (1991). Large seeded lentil is more favoured in the Egyptian market. Therefore, large seeded lentil genotypes should be introduced to Egypt and more attention should be given for selection of large seeded types. Also, results in Table 3 indicate that FLIP 95-11L had the heaviest weight of 100 seeds being 4.92 g and ranked the first followed by PKVL-1 (4.20 g) and FLIP 88-42L (4.00 g).

Consequently, these three large seeded genotypes would be used in the lentil improvement program.

Seed yield averaged 2 ardab/feddan (1 ardab = 160 kg) and had a range of 0.36 to 4.10 ard/fed. Results in Table 3 show a wide variation in seed yield among the tested genotypes. FLIP 88-34L, produced the highest seed yield/fed recording 4.10 ard/fed followed by Line (Family 300 X precoz) (3.89), XG 98-13 (3.85), Family 29 (3.60), Giza 51 (3.20) and FLIP 97-30L (3.15). These genotypes outyielded the check cultivar Giza 9 by 35, 28, 27, 19, and 3 %, respectively. In addition, some of these genotypes matured earlier than Giza 9 particularly FLIP 97-30L and Line (Family 300 X precoz) which matured 18 and 8 days earlier than Giza 9, respectively. The superiority of these six genotypes in seed yield could be attributed to their higher number of pods, seeds and seed weight/plant compared to other genotypes. These promising genotypes will be re-tested in advanced yield trials compared to other genotypes.

Data in Table 3 show also that crop efficiency (yield/day) was significantly affected by genotypes with large variability among tested genotypes. FLIP 88-34L was the most efficient in seed production (4.58 kg/day) followed by Line (Fam 300 X precoz) (4.54 kg/day), XG 98-13 (4.19), Family 29 (4.03 kg/day), FLIP 97-30L (4.00 kg/day), respectively.

**3- Seed quality:**

Mean values of seed quality characters as affected by lentil genotypes (combined over 2001/2002 and 2002/2003 seasons) are presented in Table 4. Results revealed that the tested genotypes significantly differed with respect to the studied characters.

Range of seed protein content found in the present study was 18.5 - 25.5 %, which is close to the range of seed protein previously reported by Hamdi and El-Emery (1996), El-Bagoury *et al.* (2000) and Selim (2000). Results indicated that FLIP 93-1L had the highest content of seed protein, being 25.5 % followed by Giza 51 (25.0 %) and FLIP 88-34L (24.5 %). The lowest seed protein content was produced by FLIP 86-2L being 18.5 %.

Hydration coefficient before cooking (H.C.B) for all genotypes ranged from 101 % for FLIP 86-2L to 131 % for FLIP 98-7L, while the local check Giza 9 averaged 122 %. The wide range of H.C.B indicates that the tested genotypes differed in potential to imbibe water. A high capacity to absorb water indicates good seed quality. Same results were found by Selim (2000).

The percentage amount of water uptake by cooked seeds as represented by hydration coefficient after cooking (H.C.A) ranged from 105 for FLIP 87-21L to 124 for FLIP 93-1L. Local check Giza 9 had value of 111 %. Although the range of the H.C.A value is small, the differences among genotypes allow for selection among them. In fact, during the soaking process which water imbibtion is greatly dependent on the inherent physio-chemical composition of the seed. Sathe and Salunkhe (1981) reported that the polar amino groups of protein molecules are the primary water binding sites.

For the total soluble solids (T.S.S.%), data in Table 4 clearly showed significant wide variation among the tested genotypes. FLIP 92–48L gave the highest value of T.S.S., being 1.95 while FLIP 87-70L recorded the lowest value of T. S. S. being 0.94.

On the other hand, there was a significant variation among the tested genotypes in the percentage of cookability. Most genotypes gave high percentage of cookability which was above 85 %. FLIP 2001-5L genotype gave the lowest percentage of cookability (75 %).

**Correlation analysis:**

The matrix of simple correlation coefficients among seed weight/plant and each of days to 50 % flowering and maturity, plant height, number of branches, pods and seeds/plant and weight of 100 seeds is presented in Table 5.

Results showed that the most important relationships to lentil breeder are those between seed weight/plant and each of plant height ($r = 0.499^{**}$), number of branches/plant ($r = 0.792^{**}$), number of pods/plant ($r = 0.887^{**}$), number of seeds/plant ($r = 0.919^{**}$) and weight of 100 seeds ($r = 0.278^{*}$).

Significant positive correlation was found between number of days to 50 % flowering and each of number of days to maturity ($r = 0.852^{**}$) and number of pods/plant ($r = 0.217^{*}$). However, number of days to 50 % flowering was highly significantly negatively correlated with weight of 100 seeds ($r = -0.432^{**}$). Number of days to maturity was found to be highly significantly negatively associated with 100-seed weight ($r = -0.369^{**}$). Positive highly significant correlation was detected between plant height and each of number of branches/plant ($r = 0.556^{**}$), number of pods/plant ($r = 0.521^{**}$) and number of seeds/plant ($r = 0.472^{**}$). Correlation between number of branches/plant and each of number of pods and seeds/plant and weight of 100 seeds was found to be positive highly significant with r values being $0.676^{**}$, $0.682^{**}$ and $0.429^{**}$, respectively. Highly significant positive correlation was observed between number of pods/plant and number of seeds/plant with r value of $0.934^{**}$. The previous results indicate that selection for these characters would improve the productivity of lentil crop because of their highly significant correlation with yield. These results are similar to those reported by Ezzat and Ashmawy (1999).

Correlation analysis showed that the relationships among seed weight/plant and seed quality characters were found to be non-significant and showed very small contribution to the seed yield variation. So, they were discarded from the results.

Table 2. Mean values of earliness as affected by lentil genotypes over 2001/2002 and 2002/2003 seasons.

| Genotype | | 1st flower | 50 % flowering | 100 % flowering | 50 % podding | 100 % podding | 95 % maturity |
|---|---|---|---|---|---|---|---|
| 1- FLIP 86 – 2L | | 52.5 $^{l}$ | 56.8 $^{g}$ | 63.3 $^{ij}$ | 79.8 $^{l}$ | 90.3 $^{kl}$ | 141.7 $^{f}$ |
| 2- FLIP 87 – 21L | | 51.2 $^{l}$ | 56.3 $^{gh}$ | 64.5 $^{i}$ | 76.8 $^{mn}$ | 88.5 $^{l}$ | 136.0 $^{h}$ |
| 3- Pant L 406 | | 78.7 $^{b}$ | 82.5 $^{c}$ | 90.0 $^{cde}$ | 101.0 $^{def}$ | 114.0 $^{cd}$ | 151.8 $^{bc}$ |
| 4- FLIP 87 – 70L | | 77.0 $^{bcd}$ | 8.27 $^{c}$ | 89.8 $^{cde}$ | 101.3 $^{cde}$ | 117.5 $^{b}$ | 146.5 $^{de}$ |
| 5- FLIP 88 – 7L | | 71.5 $^{hi}$ | 78.7 $^{de}$ | 84.8 $^{gh}$ | 95.0 $^{hi}$ | 105.5 $^{I}$ | 138.0 $^{h}$ |
| 6- FLIP 88 - 42L | | 47.5 $^{mn}$ | 50.0 $^{j}$ | 57.5 $^{l}$ | 84.0 $^{k}$ | 92.8 $^{k}$ | 124.0 $^{j}$ |
| 7- L E N 8830 | | 75.5 $^{c-g}$ | 81.3 $^{cd}$ | 87.7 $^{d-g}$ | 98.5 $^{fg}$ | 111.2 $^{def}$ | 151.7 $^{bc}$ |
| 8- XG 88 – 16 | | 65.7 $^{k}$ | 74.7 $^{f}$ | 82.3 $^{h}$ | 99.5 $^{efg}$ | 108.2 $^{fgh}$ | 149.0 $^{cd}$ |
| 9- FLIP 97 – 13L | | 78.7 $^{b}$ | 87.7 $^{b}$ | 93.5 $^{b}$ | 100.0 $_{def}$ | 117.0 $^{b}$ | 156.5 $^{a}$ |
| 10- FLIP 98 – 7 L | | 82.0 $^{a}$ | 92.2 $^{a}$ | 101.0 $^{a}$ | 112.0 $^{a}$ | 124.0 $^{a}$ | 152.0 $^{bc}$ |
| 11- PKVL –1 | | 41.5 $^{o}$ | 50.0 $^{j}$ | 57.0 $^{l}$ | 74.2 $^{o}$ | 81.8 $^{n}$ | 124.8 $^{j}$ |
| 12- FLIP 92 – 48L | | 74.3 $^{d-h}$ | 81.3 $^{cd}$ | 89.5 $^{de}$ | 105.0 $^{b}$ | 122.8 $^{a}$ | 146.7 $^{de}$ |
| 13- FLIP 93 – 1L | | 72.0 $^{hi}$ | 82.3 $^{c}$ | 89.7 $^{cde}$ | 98.5 $^{fg}$ | 108.5 $^{fgh}$ | 143.5 $^{f}$ |
| 14- FLIP 95 – 1L | | 73.3 $^{fgh}$ | 82.0 $^{c}$ | 88.5 $^{def}$ | 104.5 $^{b}$ | 123.2 $^{a}$ | 154.3 $^{ab}$ |
| 15- FLIP 95 – 11L | | 70.0 $^{ij}$ | 80.7 $^{cde}$ | 87.7 $^{d-g}$ | 99.5 $^{efg}$ | 114.3 $^{c}$ | 150.0 $^{c}$ |
| 16- FLIP 96 – 18L | | 68.5 $^{j}$ | 79.8 $^{cde}$ | 85.8 $^{fg}$ | 99.5 $^{efg}$ | 113.5 $^{cd}$ | 143.5 $^{f}$ |
| 17- FLIP 96 – 52L | | 45.0 $^{n}$ | 51.5 $^{j}$ | 58.7 $^{kl}$ | 76.0 $^{no}$ | 84.8 $^{m}$ | 129.0 $^{I}$ |
| 18- FLIP 2001 – 3L | | 78.0 $^{bc}$ | 86.0 $^{b}$ | 90.8 $^{bcd}$ | 101.0 $^{def}$ | 112.0 $^{cde}$ | 138.3 $^{gh}$ |
| 19- FLIP 97 – 30L | | 46.5 $^{n}$ | 52.0 $^{ij}$ | 58.8 $^{kl}$ | 75.8 $^{no}$ | 85.0 $^{m}$ | 126.0 $^{j}$ |
| 20- FLIP 97 – 33L | | 50.0 $^{lm}$ | 54.2 $^{hi}$ | 60.8 $^{jk}$ | 77.0 $^{mn}$ | 83.5 $^{mn}$ | 126.0 $^{j}$ |
| 21- XG98 – 13 | | 76.5 $^{b-e}$ | 82.7 $^{c}$ | 90.3 $^{cde}$ | 101.0 $^{def}$ | 113.3 $^{cde}$ | 147.0 $^{de}$ |
| 22- FLIP 2000 – 4L | | 51.5 $^{l}$ | 57.5 $^{g}$ | 64.3 $^{I}$ | 79.0 $^{lm}$ | 90.0 $^{l}$ | 137.7 $^{h}$ |
| 23- FLIP 2001 – 5L | | 76.0 $^{b-f}$ | 82.0 $^{c}$ | 92.8 $^{bc}$ | 102.5 $^{bcd}$ | 113.0 $^{cde}$ | 143.5 $^{f}$ |
| 24- FLIP 88 – 34L | | 75.0 $^{d-g}$ | 80.8 $^{cde}$ | 87.3 $^{efg}$ | 104.2 $^{d}$ | 113.2 $^{cde}$ | 143.0 $^{f}$ |
| 25-Line (Fam.300 Xprecoz) | | 70.0 $^{ij}$ | 80.7 $^{cde}$ | 90.5 $^{b-e}$ | 103.2 $^{bc}$ | 114.3 $^{c}$ | 136.8 $^{h}$ |
| 26- Family 29 | | 74.0 $^{e-h}$ | 78.7 $^{de}$ | 89.3 $^{de}$ | 97.0 $^{gh}$ | 107.8 $^{ghi}$ | 141.0 $^{fg}$ |
| 27- ILL 590 | | 73.0 $^{gm}$ | 78.3 $^{e}$ | 90.8 $^{bcd}$ | 104.0 $^{b}$ | 110.5 $^{efg}$ | 147.0 $^{de}$ |
| 28- Giza 9 | | 71.8 $^{hi}$ | 82.2 $^{c}$ | 87.8 $^{d-g}$ | 94.5 $^{i}$ | 107.0 $^{hi}$ | 144.0 $^{ef}$ |
| 29- Giza 51 | | 68.7 $^{j}$ | 73.2 $^{f}$ | 82.2 $^{h}$ | 91.7 $^{j}$ | 102.5 $^{j}$ | 142.5 $^{f}$ |
| 30- Sinai 1 | | 45.3 $^{n}$ | 51.2 $^{j}$ | 58.7 $^{kl}$ | 79.5 l | 88.5 $^{l}$ | 125.0 $^{j}$ |
| Mean | | 66.0 | 73.0 | 80.5 | 93.9 | 105.3 | 141.2 |
| Range | Minimum | 41.5 | 50.0 | 57.0 | 74.2 | 81.8 | 124.0 |
| | Maximum | 82.0 | 92.2 | 101.0 | 105.0 | 124.0 | 156.5 |

* Means followed with same letters are not significantly different.

Table 3.Mean values of morphological, yield and related characters as affected by lentil genotypes over 2001/2002 and 2002/2003 seasons.

| Genotypes | | Plant Height (cm.) | Number of branches /plant | Number of pods /plant | Number of seeds /plant | Seed weight /plant (g) | 100 seed weight (g) | Seed yield ardab/fed | Seed yield (kg/day) |
|---|---|---|---|---|---|---|---|---|---|
| 1- FLIP 86 – 2L | | 38.23 $^{f-j}$ | 8.50 $^{fg}$ | 12.2 $^{ij}$ | 20.20 $^{jkl}$ | 0.50 $^{dp}$ | 2.80 $^{e-i}$ | 0.85 $^{i}$ | 0.96 $^{n}$ |
| 2- FLIP 87 – 21L | | 45.06 $^{a-f}$ | 12.53 $^{a-d}$ | 20.2 $^{g-j}$ | 35.00 $^{ghi}$ | 1.11 $^{g-j}$ | 3.52 $^{cd}$ | 2.52 $^{d}$ | 2.96 $^{fg}$ |
| 3- Pant L 406 | | 47.20 $^{abc}$ | 11.00 $^{b-f}$ | 25.0 $^{e-h}$ | 43.00 $^{efg}$ | 1.20 $^{f-l}$ | 2.73 $^{f-j}$ | 2.48 $^{d}$ | 2.61 $^{gh}$ |
| 4- FLIP 87 – 70L | | 33.20 $^{j}$ | 11.20 $^{b-f}$ | 39.8 $^{cd}$ | 46.57 $^{def}$ | 0.96 $^{i-l}$ | 2.25 $^{i-l}$ | 1.82 $^{efg}$ | 1.98 $^{jk}$ |
| 5- FLIP 88 – 7L | | 24.57 $^{k}$ | 8.40 $^{fg}$ | 14.2 $^{ij}$ | 16.87 $^{kl}$ | 0.58 $^{no}$ | 3.55 $^{cd}$ | 1.23 $^{h}$ | 1.43 $^{m}$ |
| 6- FLIP 88 - 42L | | 39.50 $^{d-j}$ | 12.10 $^{a-e}$ | 32.1 $^{def}$ | 37.00 $^{fgh}$ | 1.39 $^{def}$ | 4.00 $^{bc}$ | 2.70 $^{d}$ | 3.48 $^{de}$ |
| 7- L E N 8830 | | 48.37 $^{ab}$ | 9.30 $^{d-g}$ | 31.8 $^{def}$ | 41.60 $^{efg}$ | 0.91 $^{j-m}$ | 2.20 $^{jkl}$ | 1.78 $^{efg}$ | 1.88 $^{kl}$ |
| 8- XG 88 – 16 | | 35.02 $^{ij}$ | 12.45 $^{a-e}$ | 20.1 $^{g-j}$ | 25.10 $^{ijk}$ | 0.73 $^{l-o}$ | 2.50 $^{h-k}$ | 1.85 $^{ef}$ | 1.98 $^{jk}$ |
| 9- FLIP 97 – 13L | | 43.98 $^{b-g}$ | 9.30 $^{d-g}$ | 16.6 $^{hij}$ | 21.30 $^{jkl}$ | 0.31 $^{pq}$ | 1.75 $^{lmn}$ | 0.75 $^{ij}$ | 0.76 $^{no}$ |
| 10- FLIP 98 – 7 L | | 41.82 $^{b-i}$ | 8.20 $^{fg}$ | 14.9 $^{hij}$ | 16.05 $^{kl}$ | 0.22 $^{q}$ | 1.47 $^{n}$ | 0.59 $^{ijk}$ | 0.62 $^{no}$ |
| 11- PKVL –1 | | 44.28 $^{a-g}$ | 15.20 $^{a}$ | 22.3 $^{f-i}$ | 35.00 $^{ghi}$ | 1.32 $^{d-g}$ | 4.20 $^{b}$ | 2.60 $^{d}$ | 3.11 $^{def}$ |
| 12- FLIP 92 – 48L | | 35.83 $^{hij}$ | 10.20 $^{c-f}$ | 15.9 $^{hij}$ | 19.32 $^{jkl}$ | 0.66 $^{mno}$ | 3.35 $^{de}$ | 0.82 $^{ij}$ | 0.89 $^{n}$ |
| 13- FLIP 93 – 1L | | 40.97 $^{b-i}$ | 8.35 $^{fg}$ | 12.3 $^{ij}$ | 18.30 $^{jkl}$ | 0.49 $^{op}$ | 2.55 $^{h-k}$ | 0.79 $^{ij}$ | 0.88 $^{n}$ |
| 14- FLIP 95 – 1L | | 43.03 $^{b-h}$ | 10.70 $^{b-f}$ | 29.0 $^{efg}$ | 34.85 $^{ghi}$ | 0.65 $^{mno}$ | 1.75 $^{lmn}$ | 1.50 $^{gh}$ | 1.55 $^{lm}$ |
| 15- FLIP 95 – 11L | | 40.20 $^{c-j}$ | 11.20 $^{b-f}$ | 9.7 $^{j}$ | 13.42 $^{l}$ | 0.61 $^{no}$ | 4.92 $^{a}$ | 0.89 $^{i}$ | 0.95 $^{n}$ |
| 16- FLIP 96 – 18L | | 37.02 $^{g-j}$ | 9.13 $^{efg}$ | 14.2 $^{ij}$ | 21.63 $^{jkl}$ | 0.76 $^{l-o}$ | 2.80 $^{e-i}$ | 1.20 $^{h}$ | 1.33 $^{m}$ |
| 17- FLIP 96 – 52L | | 36.25 $^{hij}$ | 10.20 $^{c-f}$ | 11.0 $^{j}$ | 20.10 $^{jkl}$ | 0.84 $^{k-n}$ | 3.30 $^{def}$ | 1.62 $^{fg}$ | 2.00 $^{jk}$ |
| 18- FLIP 2001 – 3L | | 41.90 $^{b-i}$ | 8.30 $^{fg}$ | 32.2 $^{def}$ | 39.22 $^{efg}$ | 0.61 $^{no}$ | 1.57 $^{mn}$ | 1.78 $^{efg}$ | 2.06 $^{ijk}$ |
| 19- FLIP 97 – 30L | | 48.02 $^{ab}$ | 13.47 $^{abc}$ | 34.0 $^{de}$ | 48.40 $^{cde}$ | 1.50 $^{cde}$ | 3.18 $^{d-g}$ | 3.15 $^{c}$ | 4.00 $^{c}$ |
| 20- FLIP 97 – 33L | | 35.87 $^{hij}$ | 10.80 $^{b-f}$ | 17.2 $^{hij}$ | 28.20 $^{hij}$ | 0.74 $^{l-o}$ | 2.87 $^{e-h}$ | 1.91 $^{ef}$ | 2.42 $^{hi}$ |
| 21- XG98 – 13 | | 41.67 $^{b-i}$ | 14.60 $^{a}$ | 69.6 $^{a}$ | 84.00 $^{a}$ | 2.25 $^{b}$ | 2.50 $^{h-k}$ | 3.85 $^{ab}$ | 4.19 $^{bc}$ |
| 22- FLIP 2000 – 4L | | 39.98 $^{c-j}$ | 6.87 $^{g}$ | 13.1 $^{ij}$ | 17.00 $^{kl}$ | 0.50 $^{op}$ | 2.62 $^{g-k}$ | 0.50 $^{jk}$ | 0.58 $^{no}$ |
| 23- FLIP 2001 – 5L | | 46.35 $^{a-d}$ | 10.10 $^{c-g}$ | 10.5 $^{j}$ | 12.90 $^{l}$ | 0.28 $^{pq}$ | 2.07 $^{klm}$ | 0.36 $^{k}$ | 0.40 $^{o}$ |
| 24- FLIP 88 – 34L | | 46.77 $^{a-d}$ | 13.45 $^{abc}$ | 73.5 $^{a}$ | 87.70 $^{a}$ | 2.56 $^{a}$ | 2.98 $^{d-h}$ | 4.10 $^{a}$ | 4.58 $^{a}$ |
| 25-Line (Fam300Xprecoz) | | 51.52 $^{a}$ | 13.30 $^{abc}$ | 70.0 $^{a}$ | 83.65 $^{a}$ | 2.38 $^{ab}$ | 2.77 $^{f-j}$ | 3.89 $^{ab}$ | 4.54 $^{ab}$ |
| 26- Family 29 | | 47.35 $^{abc}$ | 13.93 $^{ab}$ | 55.7 $^{b}$ | 70.35 $^{b}$ | 1.72 $^{c}$ | 2.45 $^{h-k}$ | 3.60 $^{b}$ | 4.03 $^{c}$ |
| 27- ILL 590 | | . 33.13 $^{j}$ | 10.62 $^{b-f}$ | 18.2 $^{hij}$ | 56.93 $^{c}$ | 1.05 $^{n-k}$ | 3.50 $^{cd}$ | 2.10 $^{e}$ | 2.27 $^{hij}$ |
| 28- Giza 9 | | 40.53 $^{c-j}$ | 12.13 $^{a-e}$ | 45.0 $^{c}$ | 57.00 $^{c}$ | 1.27 $^{e-h}$ | 2.15 $^{kl}$ | 3.03 $^{c}$ | 3.36 $^{de}$ |
| 29- Giza 51 | | 46.15 $^{a-e}$ | 13.0 $^{abc}$ | 45.0 $^{c}$ | 55.90 $^{cd}$ | 1.56 $^{cd}$ | 2.80 $^{e-i}$ | 3.20 $^{c}$ | 3.59 $^{d}$ |
| 30- Sinai 1 | | 38.78 $^{e-j}$ | 10.3 $^{c-f}$ | 31.0 $^{def}$ | 43.00 $^{efg}$ | 1.12 $^{g-j}$ | 3.48 $^{cd}$ | 2.50 $^{d}$ | 3.20 $^{ef}$ |
| Mean | | 41.09 | 10.96 | 28.5 | 38.42 | 1.03 | 2.82 | 2.00 | 2.15 |
| Range | Minimum | 24.57 | 6.87 | 9.7 | 12.90 | 0.22 | 1.47 | 0.36 | 0.40 |
| | Maximum | 51.52 | 15.2 | 73.5 | 87.70 | 2.56 | 4.92 | 4.10 | 4.58 |

* Means followed with same letters are not significantly different. ** 1 ardeb = 160 kg

Table 4. Mean values of seed quality characters as affected by lentil genotypes over 2001/2002 and 2002/2003 seasons.

| Genotypes | | Seed protein % | H. C. B % | H. C. A % | T. S. S % | Cook % |
|---|---|---|---|---|---|---|
| 1- FLIP 86 – 2L | | 18.5 $^{i}$ | 101.0 $^{m}$ | 111.5 $^{e-i}$ | 1.14 $^{jkl}$ | 92.5 $^{a}$ |
| 2- FLIP 87 – 21L | | 21.5 $^{d-h}$ | 121.5 $^{d-g}$ | 105.0 $^{l}$ | 0.97 $^{mn}$ | 97.5 $^{a}$ |
| 3- Pant L 406 | | 23.5 $^{a-d}$ | 103.5 $^{lm}$ | 110.0 $^{ghi}$ | 1.02 $^{k-n}$ | 95.0 $^{a}$ |
| 4- FLIP 87 – 70L | | 18.5 $^{i}$ | 102.5 $^{m}$ | 105.5 $^{hi}$ | 0.94 $^{n}$ | 95.0 $^{a}$ |
| 5- FLIP 88 – 7L | | 22.0 $^{d-g}$ | 123.0 $^{c-f}$ | 106.0 $^{hi}$ | 1.00 $^{lmn}$ | 85.0 $^{ab}$ |
| 6- FLIP 88 - 42L | | 23.5 $^{a-d}$ | 114.0 $^{ijk}$ | 113.0 $^{d-g}$ | 1.20 $^{j}$ | 97.5 $^{a}$ |
| 7- L E N 8830 | | 22.0 $^{d-g}$ | 119.5 $^{e-i}$ | 120.0 $^{abc}$ | 1.85 $^{ab}$ | 92.5 $^{a}$ |
| 8- XG 88 – 16 | | 22.5 $^{c-f}$ | 120.5 $^{e-h}$ | 114.5 $^{c-g}$ | 1.18 $^{j}$ | 97.5 $^{a}$ |
| 9- FLIP 97 – 13L | | 22.5 $^{c-f}$ | 125.0 $^{b-e}$ | 122.0 $^{ab}$ | 1.57 $^{d}$ | 85.0 $^{ab}$ |
| 10- FLIP 98 – 7 L | | 21.0 $^{e-h}$ | 131.0 $^{a}$ | 114.0 $^{c-g}$ | 1.77 $^{b}$ | 87.5 $^{ab}$ |
| 11- PKVL –1 | | 23.5 $^{a-d}$ | 127.0 $^{a-d}$ | 111.5 $^{e-i}$ | 1.58 $^{d}$ | 97.5 $^{a}$ |
| 12- FLIP 92 – 48L | | 23.0 $^{b-e}$ | 108.5 $^{kl}$ | 119.0 $^{a-d}$ | 1.95 $^{a}$ | 90.0 $^{ab}$ |
| 13- FLIP 93 – 1L | | 25.5 $^{a}$ | 129.0 $^{ab}$ | 124.0 $^{a}$ | 1.10 $^{j-m}$ | 92.5 $^{a}$ |
| 14- FLIP 95 – 1L | | 22.0 $^{d-g}$ | 121.5 $^{d-g}$ | 119.5 $^{a-d}$ | 1.40 $^{efg}$ | 95.0 $^{a}$ |
| 15- FLIP 95 – 11L | | 21.0 $^{e-h}$ | 129.0 $^{ab}$ | 116.5 $^{b-g}$ | 1.38 $^{fgh}$ | 87.5 $^{ab}$ |
| 16- FLIP 96 – 18L | | 22.0 $^{d-g}$ | 127.5 $^{abc}$ | 116.0 $^{b-g}$ | 1.23 $^{ij}$ | 95.0 $^{a}$ |
| 17- FLIP 96 – 52L | | 19.5 $^{hi}$ | 120.5 $^{e-h}$ | 111.0 $^{f-i}$ | 1.25 $^{hij}$ | 95.0 $^{a}$ |
| 18- FLIP 2001 – 3L | | 20.5 $^{f-i}$ | 115.0 $^{hij}$ | 113.5 $^{c-g}$ | 1.15 $^{jk}$ | 87.5 $^{ab}$ |
| 19- FLIP 97 – 30L | | 22.0 $^{d-g}$ | 122.5 $^{c-g}$ | 120.0 $^{abc}$ | 1.23 $^{ij}$ | 95.0 $^{a}$ |
| 20- FLIP 97 – 33L | | 23.0 $^{b-e}$ | 119.0 $^{e-i}$ | 112.0 $^{e-h}$ | 1.21 $^{j}$ | 92.5 $^{a}$ |
| 21- XG98 – 13 | | 21.0 $^{e-h}$ | 116.5 $^{g-j}$ | 113.0 $^{d-g}$ | 1.01 $^{k-n}$ | 97.5 $^{a}$ |
| 22- FLIP 2000 – 4L | | 20.0 $^{ghi}$ | 122.0 $^{c-g}$ | 119.0 $^{a-d}$ | 1.57 $^{d}$ | 97.5 $^{a}$ |
| 23- FLIP 2001 – 5L | | 19.5 $^{hi}$ | 114.0 $^{ijk}$ | 111.0 $^{f-i}$ | 1.52 $^{def}$ | 75.0 $^{b}$ |
| 24- FLIP 88 – 34L | | 24.5 $^{abc}$ | 118.5 $^{f-j}$ | 115.5 $^{b-g}$ | 1.61 $^{cd}$ | 97.5 $^{a}$ |
| 25-Line (Fam.300 X precoz) | | 23.5 $^{a-d}$ | 118.5 $^{f-j}$ | 119.0 $^{a-d}$ | 1.72 $^{bc}$ | 95.0 $^{a}$ |
| 26- Family 29 | | 25.0 $^{ab}$ | 113.0 $^{jk}$ | 117.5 $^{a-f}$ | 1.10 $^{j-m}$ | 95.0 $^{a}$ |
| 27- ILL 590 | | 20.5 $^{f-i}$ | 117.0 $^{f-j}$ | 113.0 $^{d-g}$ | 1.36 $^{ghi}$ | 95.0 $^{a}$ |
| 28- Giza 9 | | 22.5 $^{c-f}$ | 122.0 $^{c-g}$ | 111.0 $^{f-i}$ | 1.53 $^{de}$ | 97.5 $^{a}$ |
| 29- Giza 51 | | 25.0 $^{ab}$ | 125.0 $^{b-e}$ | 111.5 $^{e-i}$ | 1.48 $^{d-g}$ | 90.0 $^{ab}$ |
| 30- Sinai 1 | | 23.0 $^{b-e}$ | 119.5 $^{e-i}$ | 118.0 $^{a-e}$ | 1.16 $^{jk}$ | 92.5 $^{a}$ |
| Average | | 22.10 | 118.9 | 114.4 | 1.34 | 93.5 |
| Range | Minimum | 18.5 | 101.0 | 105.0 | 0.94 | 75.0 |
| | Maximum | 25.5 | 131.0 | 124.0 | 1.95 | 97.5 |

* Means followed with same letters are not significantly different.

Table 5: Matrix of simple correlation coefficients among seed weight/plant and its components in lentil over 2001/2002 and 2002/2003 seasons.

| Characters | | X1 | X2 | X3 | X4 | X5 | X6 | X7 |
|---|---|---|---|---|---|---|---|---|
| 50 % flowering | X1 | 1.000 | | | | | | |
| Maturity | X2 | 0.852** | 1.000 | | | | | |
| Plant height | X3 | 0.130 | 0.130 | 1.000 | | | | |
| Branches/plant | X4 | -0.040 | -0.073 | 0.556** | 1.000 | | | |
| No.of pods/plant | X5 | 0.217* | 0.035 | 0.521** | 0.676** | 1.000 | | |
| No.of seeds/plant | X6 | 0.162 | 0.009 | 0.472** | 0.682** | 0.934** | 1.000 | |
| 100-seed weight | X7 | -0.432** | -0.369** | -0.007 | 0.429** | -0.046 | 0.034 | 1.000 |
| Weight of seeds/plant | Y | 0.027 | -0.163 | 0.499** | 0.792** | 0.887** | 0.919** | 0.278* |

* Significant at 5 % level of significant.
** Significant at 1% level of significant.

**Factor analysis:**

Results of factor analysis are shown in Tables 6 and 7. Factors were constructed by applying the principal factor analysis approach to establish the dependent relationship between yield components in lentil. Factor analysis grouped the studied seven characters into two main factors. Factor loadings greater than 0.5 were considered important. Table 7 presents the composition of variables of the two factors with loadings.

Table 6: Principal factor matrix after orthogonal rotation for seven characters of lentil

| Variables | Factors | | Communality |
|---|---|---|---|
| | Factor I | Factor II | ($h^2$) |
| Days to 50 % flowering. | 0.167 | 0.913 | 0.861 |
| Days to maturity. | 0.052 | 0.889 | 0.793 |
| Plant height. | 0.711 | 0.099 | 0.515 |
| Number of branches/plant. | 0.862 | -0.258 | 0.810 |
| Number of pods/plant. | 0.922 | 0.096 | 0.859 |
| Number of seeds/plant. | 0.913 | 0.033 | 0.835 |
| Weight of 100 seeds. | 0.153 | -0.702 | 0.516 |
| Latent roots | 2.986 | 2.203 | 5.19 |
| Factor variance ratio % | 42.66 | 31.47 | 74.13 |

Table 7: Summary of factor loading for seven variables of lentil.

| Variables | Loading | % of total communality | Suggested factor name |
|---|---|---|---|
| **Factor I:** | | | |
| 1- Plant height. | 0.711 | 42.66 | Seed |
| 2- Number of branches/plant. | 0.862 | | |
| 3- Number of pods/plant. | 0.922 | | |
| 4- Number of seeds/plant. | 0.913 | | |
| Factor II: | | | |
| 1- Days to 50 % flowering. | 0.913 | 31.47 | Maturity |
| 2- Days to maturity. | 0.889 | | |
| 3- Weight of 100 seeds. | -0.702 | | |
| Commulative variance | | 74.13 | |

The results indicate that the two obtained factors explained 74.13 % of the total variation in the dependent structure. Factor I accounted for 42.66 % of the total variability and included four variables, *i.e.* plant height, number of branches/plant, number of pods and seeds/plant. The four variables positively correlated with the factor. These variables had equal importance and high communality with factor I. Therefore, this factor may be called seed factor.

Factor II could be regarded as maturity factor because it contained number of days to 50 % flowering, number of days to maturity and weight of 100 seeds. This factor was responsible for 31.47 % of the total variation in the dependent structure (Table 7). Two variables of factor II which were days to 50 % flowering and maturity had positive loading while weight of 100 seeds had negative loading. The sign of the loading indicates the direction of the relationship between the factor and the variable.

The results of the current study indicated that the estimated communalities (Table 6) were adequate for conclusion since both obtained factors contributed 74.13 % to the total variability of the dependent structure.

Factor I (seed factor) had high loadings for the included variables (Table 6). The correlation between these variables and factor I is given by the suitable factor loading. Based on the studied genotypes, selection for plant height, number of branches, pods and seeds/plant will enable plant breeders to obtain higher yield.

From the previous results, it could be concluded that factor analysis indicates both grouping and percentage contribution to the total variability in the dependent structure. Using factor analysis by plant breeders has the potential of increasing the comprehension of causal relationship of variables and can help to determine the nature and sequence of traits to be selected in a breeding program. This may be helpful in planning an appropriate selection strategy to improve lentil crop.

## REFERENCES

1. A. O. A. C. 1990. Official methods of analysis of the association of official analytical chemists. 15$^{th}$, A.O.A.C., Washington, USA.
2. Ashmawy, F., S. A. S. Mehasen and M. S. A. Mohamed 1998. The relative contribution of some characters to seed yield in some faba bean varieties grown under three population densities. Bull. Fac. Agric., Cairo Univ., 49(4): 517-532.
3. Cattel, R. B. 1965. Factor analysis: An introduction to essential. I- The purpose and underlying models. Biometrics, 21:195-215.
4. El-Bagoury, A. A, Hanan E. Kassab and Ragaa Zein 2000. Effect of soaking and cooking methods on organoleptic evaluation and some chemical constituents of mung bean and lentil. J. Agric. Sci. Mansoura Univ., 25(5) : 2753 – 2765.

5. Ezzat, Zakia M. and F. Ashmawy 1999. Performance of some exotic lentil genotypes under Egyptian conditions. Zagazig. J. Agric. Res., 26: 267-280.

6. Fahmy, H. M., S. Stivastava and M. A. Ubersax 1996. Physical and textural characteristics of soaked and cooked American common Beans. Egypt. J. Food Sci. 24(2): 1

7. Hamdi, A., W. Erskine and P. Gates 1991. Relationships among economic characters in lentil. Euphytica, 57:109-116.

8. Hamdi, A. and M. I. EL-Emery 1996. Evaluation of some seed quality characters in the promising lentil genotypes in Egypt. Annals Agric. Sci., Ain Shams Univ., Cairo, 41(2): 725-738.

9. Hamdi, A. and Zakia M. Ezzat 1998. Qualitative and quantitative characters and their associations of lentil germplasm. Egyptian J. Pl. Breed. 2:43-55.

10. Hamdi, A, R. E. El-Lathy, M. Shaaban and Zakia M. Ezzat 2003. Performance of some lentil genotypes in the New Recliamed lands at Abu-Simbel. Egypt. J. Agric. Res., 81(3):

11. Ibrahim, M. A. M. 2001. Variation study of earliness in some lentil genotypes. M. Sc. Thesis, Fac. Agic., AL-Azhar Univ.

12. Kaiser, H. F. 1958. The varimax criterion for analytic notation in factor analysis. Psychometrica, 23:187-200.

13. Sathe, S. K. and D. K. Salunkhe 1981. Functional properties of the great northern (Phaseolus vulgaris L.) proteins emulsion, foamin, foaming viscosity and gelatin properties. J. Food Sci., 46:71.

14. Selim, T. A. A. 2000. Genotype and environmental effects on seed yield, yield components and seed quality in lentil. Msc. Thesis, Fac. Agric., AL-Azhar Univ.

15. Snedecor, G. W. and G.W. Cochran 1980. Statistical methods, 7th Ed. The Iowa State Univ. Press Amess, Iowa, USA.

16. Walton, P. D. 1972. Factor analysis of yield in spring wheat (Triticum aestivum L.). Crop Sci., 12 (4): 731-733.

# تقييم بعض التراكيب الوراثية للعدس للتبكير فى النضج والمحصول ومكوناته و صفات جودة البذور

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أقيمت تجربة حقلية فى محطة الجيزة للبحوث الزراعية موسمى ٢٠٠١/٢٠٠٢ و٢٠٠٢/٢٠٠٣ تضمنت ثلاثين تركيبا وراثيا من العدس بعضها مستورد من المركز الدولى للبحوث الزراعية فى المناطق الجافة (ايكاردا) والبعض الاخر من مصر بهدف تقييم التبكير والمحصول ومكوناته وصفات الجودة بالاضافة إلى تحديد العوامل المساهمة فى تباين المحصول حيث استخدم لذلك طريقتى الارتباط البسيط وتحليل العامل .

أوضحت النتائج أن التراكيب الوراثية FLIP 88-42L، PKVL – 1، FLIP 96-52L ، FLIP 97-30L ، FLIP 97-33L ، Saini 1 كانت الابكر فى التزهير و النضج. سجل التركيب الوراثى Line (Family 300 X Precoz) أعلى القيم لارتفاع النبات (٥١,٥ سم) متفوقا على جيزة ٩ بحوالى ١٠,٩٩ سم و أحتل PKVL-1 المرتبة الاولى من حيث عدد أفرع النبات بينما أعطى FLIP 88-34L أعلى قيمة لكل من عدد قرون وبذور النبات. وكذلك أعطت التراكيب الوراثية FLIP 88-34L ، Line (Family 300 X Precoz) و الهجين (XG 98-13) أعلى محصول بذور للنبات ، بينما كان أكبر وزن ١٠٠ بذرة ناتجا من FLIP95-11L (٤,٩٢ جم) يليه PKVL-1 (٤,٢٠ جم) ثم FLIP 88-42L (٤ جم). سجل التركيب الوراثى FLIP 88-34L أعلى القيم لمحصول البذور للفدان (٤,١٠ أردب / ف ) متفوقا على جيزة ٩ بحوالى ٣٥ % وايضا أعلى كفاءة فى استخدام الأرض (محصول بذور فى اليوم) (٤,٥٨ كجم / يوم ).

أظهرت النتائج أيضا أن التراكيب الوراثية FLIP 93-1L ، Family 29 ، FLIP 88-34L ، جيزة ٥١ سجلت أعلى نسبة للبروتين فى البذرة. تراوح معامل الامتصاص للبذور بعد الطهى بين ١٠٥ للتركيب الوراثى FLIP 87-21L إلى ١٢٤ للتركيب الوراثىFLIP 93-1L بينما تراوح معامل الامتصاص للبذور قبل الطهى من ١٠١ (FLIP 86-2L) إلى ١٣١ ( FLIP 98-7L). و أعطى التركيب الوراثى فيليب FLIP 92-48L أعلى القيم لنسبة المواد الصلبه الذائبه وسجلت معظم التراكيب الوراثية نسب عالية لصفة الطبخ (أعلى من ٨٥ %).

أوضحت النتائج وجود ارتباط معنوى موجب بين محصول بذورالنبات وكل من ارتفاع النبات وعدد أفرع النبات وعدد قرون النبات وعدد بذور النبات ووزن١٠٠ بذرة. وأظهرت نتائج تحليل العامل أن الصفات تحت الدراسة تجمعت فى عاملين فقط ساهما بحوالى ٧٤,١٣ % فى التباين الكلى لمحصول البذور وضم العامل الاول صفات ارتفاع النبات وعدد أفرع النبات وعدد قرون النبات وعدد بذور النبات وقد ساهم هذا العامل بحوالى ٤٢,٦٦ % فى التباين الكلى لمحصول البذور أما العامل الثانى فقد ساهم بحوالى ٣١,٤٧ % فى التباين الكلى للمحصول وضم صفات عدد الايام حتى ٥٠ % تزهير وعدد الايام حتى النضج ووزن ١٠٠ بذرة.