SUMMARY AND CONNCLUSIONS

The present study was carried out at Giza research station, Agricultural Research Center, Egypt during the three winter seasons of 2002/03, 2003/04, and 2004/05. The materials included five F_3-lentil populations, where about 6000 seeds from each F_3 population were sown on 18 December 2002. The wide spread local variety Giza 9 and the early maturing variety Sinai 1 were used as checks. At maturity, 100 plants from each F_3 population were selected on the basis of number of pods/plant. A total of 20 plants were selected separately and randomly from each F_3 population, as well as, from check varieties, Giza 9 and sina 1, and the following characters were measured in each plant:

1- Plant height (cm).
2- Total number of branches/plant.
3- Number of pods/plant.
4- Number of seeds/plant.
5- Number of seeds/pod (estimated from 20 pods/F_3 population).
6- Biological yield /plant (g).
7- Seed yield/plant (g).
8- Harvest index (seed yield/plant ÷ biological yield / plant) x 100).
9- Plant growth vigor (1-high, 2-mediam, 3-low vigor).
10- Days to 50% flowering.
11- Days to 90% maturity.

The characters numbers 9, 10 and 11 were measured on the plot-basis.

The 100 selected plants from each F_3 Population were ranked according to their seed yield.' The plants, which significantly exceeded the yield of Giza 9, were selected to be growing as F_4 families in next season. The total number of selected plants from F_3 to be planted as F_4 families were 6, 6, 5, 17, and 21 for cross 1, 2, 3, 4 and 5, respectively. The seeds of these plants were saved for planting in F_4 generation.

In 2003/04-winter season, the seeds of the selected F_3 plants were planted as F_4 families on 13 December 2003. A randomized complete block design with two replicates was used. Each replicate contained 57 plots (55 plots for all the five crosses and two plots for Giza 9 and Sinai 1). Field practices were applied as used in F_3 generation and all the characters measured in F_3 generation were also measured. The highest three seed yield plants in every F_4 family were selected and saved to be grows in F_5 generation.

In 2004/05, the seeds of the three selected F_4 plants were planted as F_5 families on 27 October 2004. A randomized complete block design with three replicates was used, and each replicate contained 167 plots (165 plots for all the five crosses and two plots for Giza 9 and Sinai 1). Field practices were applied as used in F_4 generation and all the characters measured in F_4 generation were also measured.

The analysis of variance was performed, for each F_4 and F_5 families of every cross separately (including Giza 9 and Sinai 1) with randomized complete black design. The least significant differences (L.S.D) was estimated and used to compare among means of the families, Giza 9 and Sinai 1. The analysis of variance was made for each F_4 and F_5 families in each cross again, but excluding Giza 9 and Sinai 1. In addition the variance of F_4 and FS families in every cross was estimated separately using MSTAT computer program. The various genetic parameters; phenotypic, genotypic and error variances, broad sense heritability, expected genetic advance from selection, phenotypic (P.C.V), genotypic (G.C.V) and environmental (E.G.V) coefficient of variation were estimated. Simple correlation coefficients among all studied characters were calculated for F_4-families and F_5 families.

The obtained results could be summarized in the following points:

1- The average seed yield/plant in F_3 was very low in all crosses, except cross 3, and ranged from 0.I6 g for cross 2 to 0.97 g for cross 5. Cross 3 gave a reasonable average seed yield of 1.47 g/plant. Low seed yield was mainly due to broomrape's (Orobanche) infection, which spread over the field. However, many plants were not infected and gave reasonable seed yield. Thus, useful selection was practiced in all the five crosses. Many selected plants gave seed yield above 1.4 g/plant with ovarall average seed yields of the five crosses ranging from 1.0 to 1.8 g/plant.

2- The response to selection was measured as the percentage increase of F_4 values over F_3 values for all studied characters. The data indicate the superiority of F_4 values over F_3 values for of the most studied characters. For example, seed yield/plant in F_4, cross 1, increased by 583.64% (about six times) over the corresponding value of F_3, and the percentage increase of other crosses ranged from 48.23% for cross 3 to 1856.25% for cross 2. Similarly, the percentage increases of number of pods/plant of F_4 over F_5 were high and ranged from 49.02% to 548.85%. All other characters showed similar superiority in F_4 over FS but with various values of increases, except the characters: plant vigor in crosses 2,3, 4 and 5, harvest index in cross 3, and number of seeds/pod in cross 3, which had negative response. Days to flowering and maturity showed positive response in all crosses, which means that F_4 families were late in flowering and maturity compared to F_3 families.

3- The results of F_4 crosses indicate that there are highly significant differences among families for several characters, which make it clear that there are opportunities for improving those characters by selection within the population. Estimates of broad sense heritability showed that seed yield/plant, days to

flowering, biological yield/plant and number of branches/plant had high values of >80%.

4- The genetic advance from selection depends on the heritability estimate and the magnitude of phenotypic variance. In order to determine the validity of selection, expected genetic advance should be obtained. In addition, heritability estimates together with genetic gains are more useful than the heritability values alone in predicting the resultant effect of selecting the best individuals. For example, in cross 1 in F_4, number of branches/plant, which had high broad sense heritability (82.94%) had low genetic advance (23.07%) because its coefficient of phenotypic variation was low (6.80). In comparison plant growth vigor, which had a low heritability (50.0%), had a high genetic advance percentage of 30.71% due to its high coefficient of phenotypic variation (29.81%).

5- The results of F_4 generation show that seed yield/plant correlated positively and significantly with number of pods/plant and number of seeds/plant in all crosses. The results suggested that selection for high number of pods/plant would be an efficient method for improving seed yield. The relationships among the two main yield components, number of pods/plant and number of seeds/plant, showed strong association between them, indicating selection for one of them is enough to improve yield. Moreover, in most cases there was no significant correlation between number of pods/plant and number of seeds/plant with number of seeds/pod. These results indicate that it would be difficult to achieve a response to selection for high levels of pods/plant and /or seeds/plant and number of seeds/pod.

6- In F_5 generation, the response to selection was also high. For example, seed yield/plant in cross 2 increased by 841.25% (about eight times) over the corresponding value of F_3, and the percentages increases of other crosses ranged from 43.81% for

cross 3 to 208.36% for cross 1. Similarly, the percentages increases of number of pods/plant of F_5 over F_3 were high and ranged from 14.01% to 131.23%. Most other characters showed similar superiority in F_5 over F_3 but with various values of increase, except several characters. Days to flowering and maturity showed positive effects in all crosses, which mean that the F_5 families were late in Flowering and maturity compared to F_3 families.

7- The results of F_5 show -the existence of highly significant differences among families for several characters, which make! it clear that there are opportunities for improving those characters by selection within the population. Estimates of broad sense heritability showed that several characters had high values of broad sense heritability above 80%.. Genetic advance is also of considerable importance because it indicates the magnitude of the expected genetic gain from one cycle of selection. The genetic advance from selection depends on the heritability estimate, the magnitude of phenotypic variance.

8- The associations between plant characters of F_5 generation show that seed yield/plant correlated positively and significantly with number of pods/plant and number of seeds/plant in all crosses. The results suggested that selection for high pods/plant would be an efficient method for improving seed yield. The relationships among the two main yield components, number of pods/plant and number of seeds/pod, showed strong association, indicating selection for one of them is enough to improve yield. Moreover, in most cases there was no significant correlation between number of pods/plant and number of seeds/plant with number of seeds/pod. These results indicate that it would be difficult to achieve a response to selection for high levels of pods/plant and /or seeds/plant and number of seeds/pod.

9- Number of branches/plant (primary and secondary branches) correlated negatively or not correlated, in most cases, with harvest index. The results indicate that it is possible select for high seed yield/plant with a reduced number of branches/plant.

10- Wide variation in average seed yield/plant among F_3, F_4, and F_5 was dected. The Average seed yield of these generations was 0.74, 3.36, and 1.72 g/plant, respectively. This wide variation was due to genetic variation among various generations and environmental effects. As mentioned before, Orobanche affected F_3, which dramatically influenced seed yield. F_5 was planted very early on 27 October 2004, while F_4 planted in proper optimum date on 13 December 2003 (the recommended date of planting for lentil is between 15 November to 15 December in North Egypt). It seems that date of planting played an important role on the performance of the families. This was clear for time from planting to maturity, which was 127.37 days in F_4, while it increased to 170.99 days in F_5. These results suggest that, the possibility of rising yield levels through improved crop management practices, especially date of planting.

11- The families in this study showed wide genetic diversity, allowing selection for high-yielding lentil families. There was a significant and positive correlation among seed yields of both F_4 and F_5 families *(r* = 0.583**), indicating that most selected high yield families in F_4 gave high seed yield in F_5. There are about 20 selected families in F_5 that gave seed yield higher than the local checks Giza 9 and Sinai 1. These families are no's 3, 10, and 12 in cross 1; no. 2 in cross 2; nos. 2 and 5 in cross3; nos. 3, 6, 14, 23, and 30 in cross 4, and nos. 1, 2, 5, 6, 7, 17, 18, 30 and 31 in cross 5. These families exceeded the seed yield of Giza 9 by a range of 69.8% - 159.7%. All these families are considered promising and should be exploited in lentil improvement programs.

LITERATURE CITED

Abdalla, I.S.M.; S.H. Salih and F.A. Salih (1989). Performance of exotic lentil genotypes in Sudan. Lens Newsletter, 16 (2): 10-2.

Abo-Elwafa A. (1994). Traditional and tissue culture selection in two lentil (*Lens culinaris* Medikus) populations. Ph.D. Thesis, Agronomy Dep. Assiut University, Egypt.

Abo-Elwafa A. and A.A. Ismail (1999). Selection for yield and protein in two populations of lentil. Assiut J. of Agric. Sci. 30: 93-102.

Abo-Shetaia, A.M., A.A.A. El-Gawad, A.M. Khattab and S.A. Mokhtar (1997). Physiological parameters and yield attributes as selection criteria in lentil crop. Annals of Agric. Sci. Cairo 42: 323-336.

Ahmed, F. and M.P. Pandey (1983). Stability of yield and its components in lentil. Lens Newsletter, 10 (2): 12-15.

Allard, R.W. (1960). Principle of Plant Breeding. John Wiley & Sons Inc., New York, pp.485.

Baidya, B.N.; A.M. Eunus and S. Sen (1988). Estimation of variability and correlation in yield and yield contributing characters in lentil (*Lens culinaris* Medik). Environ. and Ecology, 6 (3): 694-697.

Balyan, H.S. and S. Singh (1986). Characters associations in lentil. Lens Newsletter, 13: 1-3.

Burton, G.W. (1952). Quantitative inheritance in grasses. Proc. VI Int. Grassland Congr. 1: 222-283.

Chauhan, M.P. and I.S. Singh (1998). Genetic variability, heritability and expected genetic advance for seed yield and other quantitative characters over two years in lentil. Lens Newsletter, 25: 3-6.

Chauhan, V.S. and P.K. Sinha (1982). Correlation and path analysis in lentils. Lens Newsletter, 9: 19- 21.

Dixit-Pratibhu and D.K. Dubey (1984). Path analysis in lentil (*Lens culinaris* Medik.). Lens Newsletter, 11 (2): 15- 17.

Dixit, P. and D.K. Dubey (1985). Heritability and genetic advance in induced mutants of lentil (*Lens culinaris* Med.) Indian J.of Genetics and Plant Breeding, 45 (3):520-524.

Dixit, R.K. and P. Singh (1975). Path analysis and selected indices in lentil (*Lens esculenta* Mocnch). Plant Sci., 7: 84- 86.

Eissa, A.M.; M.A. El- Morshidy; E.E. Mahdy and A.A. El-Wafa (1987). Correlation and path coefficient analysis in lentil. Assiut. J. of Agric. Sci., 18 (3): 103- 118.

El-Hady, M.M. (1983). Study of inheritance of some economic characters in lentil. M.Sc. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., Egypt.

El- Shawaf, I.I; H.S. Sherif; A.M. Hassan; H.R. Nazeen and M.M. El–Hady (1984). Quantitative study on yield and yield components in lentil (*Lens culinaris* Medik.) Proc. 2 nd Mediterranean Conf. Genet., Cairo, March 1984, 247-270.

El-Titi, M.S. (1988). Genetic variation and interrelationships for several quantitative characters in segregating populations in lentil (*Lens culinaris* Medic.). M.Sc. Thesis, Dept. of plant production. Jordan Univ., Amman, Jordan.

Erskine, W. (1983). Relationship between the yield of seed and straw in lentil. Field Crops Res., 7 (2): 115- 121.

Erskine, W. and W.J. Goodrich (1988). Lodging in lentil and its relationship with other characters. Canad. J. of plant Sci., 68:929-934.

Erskine, W., **A Hamdi and A.A.A., Nofal, (1986)**. Screening for seed size in bulk segregating lentil populations. Lens Newsletter, 13 (2): 8-10.

Erskine, W. and J.R. Witcombe (1984). Lentil germplasm Catalog. ICARDA.

Erskine, W.; P.C. Williams and H. Nakkoul (1985). Genetic and environmental variation in the seed size, protein, yield and cooking quality of lentil. Field Crops Res., 12: 153- 161.

Esmail, A.M; A.A. Mohamed; A. Hamdi and E.M. Rabie (1994 a). Performance of some F_5 sergeants derived from four lentil crosses. Annals of Agric. Sci. Moshtolar, 32 (2): 799- 816.

Esmail, A.M.; A.A. Mohamed; A. Hamdi and E.M. Rabie (1994 b). Genetic variability and heritability for agronomic traits in segregating populations of lentil (*Lens culinaris* medik). Annals of Agric. Sci. Moshtolar, 32 (3): 1107- 1118.

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

Falconer, D.S. (1981). Introduction to quantitative genetics. 2nd edition, The Ronald Press Company, New York.

Gomez, K.A. and A.A. Gomez (1984). Statistical procedures for agricultural research. 2nd edition, John Wiley & Sons, Inc.

Gray, L., C. Pastrana, N. Collavino and W. Erskine (1996). Arbolito, a new cultivar of lentil in Argentina. Lens Newsletter, 23: 57- 58.

Hamdi, A. (1987). Variation in lentil (*Lens culinaris* Medik.) in response to irrigation. Ph. D. Thesis, Fac. of Sci., Durham Univ., Durham, U.K.

Hamdi, A. (1992). Heritability and combining ability of root characters in lentil (*Lens culinars* Medik.) Egypt. J. Agric. Res. 70 (1): 247- 252.

Hamdi, A. and W. Erskine (1990). Heritability of plant height and lowest pod height in lentil. Agric. Res. Rev., 68 (7): 1497-1509.

Hamdi, A.; W. Erskine and P. Gates (1990). Heritability and combining ability of yield and its components and earliness in lentil. Proc. 4th Conf. Agron. Cairo, 15-16 Sept. 1: 511-526.

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

Hamdi A.; A.A. El-Gharaib; S.A. Shafey and M.A.M. lbrahim (2003 a). Direct and indirect relationships among lentil characters. Egyptian J. Agric. Res. 81 (1): 139 – 150.

Hamdi, A.; A.A. El-Gharaib; S.A. Shafey and M.A.M. lbrahim (2003 b). Genetic variability, heritability and expected genetic for earliness and yield from selection in lentil. Egyptian J. Agric. Res. 81 (1): 125-138.

Hamdi, A.; Somia, M. Morsy and E.M. El-Ghareib (2002). Genetic and environmental variation in seed yield and its components, protein and cooking quality of lentil. Egyptian J. Agric. Res. 80 (2): 737-752.

Hamdi, A.; R.E El–Lathy; M. Shaaban; Z.M. Ezzat (2003 c). Performance of some lentil genotypes in the new reclaimed lands at Abu Simbel. Egyptian J. Agric. Res. 81(3): 1117-1135.

Hamdi, A.; A.M. Khattab and M.K. El- Waraki (1991 b). Genotype x environment interaction and stability analysis for seed yield of lentil Fayoum J. Agric. Res. & Dev., 5: (2) 1- 15.

Hamdi, A. and B.M.B. Rabeia (1990). Genetic variability of Egyptian landraces of lentil (*Lens culinaris* Medik). Proc. 4th Conf. Agron. Cairo, 15- 16 Sept., 1: 527-533.

Hamdi, A. and B.M.B. Rabeia (1991). Genetic and environmental variation in seed yield, seed size acooking quality. Annals of Agric. Sci. Moshtolar, 29 (1): 51-60.

Hamdi, A. and zakia M. Ezzat (1998). Qualitative and quantitative characters and their associations of lentil germplasm. Egypt. J. Plant breeding, 2: 43-55.

Hamdi, A., M. Shabaan, and E. El-Abbas (2004). Yield potential of some lentil genotypes under salinity conditions in north Egypt. Egyptian j. Agric. Res. 82 (2): 685-696.

Hassan, M.W. A., M.A.M. Risk, A.M.A.M. Khattab, A.H.A. Hussein, A.A. EI- Bayoumi and M.I.A. Amer. 1988. New released lentil varieties Giza 29 and Giza 370. Annals of Agricultural Science, Ain-Shams University, 33: 261- 276.

Jaimini, S.N.S. Goyal, S.B.S.Tikha, P.C. Bordia and S. Kumar (1971). Genetic variability and correlation studies in lentil (*Lens culinaris* Moench). Rajasthan j. Agric Sci. 2 (2) : 120-124.

Jain, SK.; H.L. Sharma; R.B. Mehra and J.P. Khare (1991). Multiple correlation and regression analysis in lentil. Lens Newsletter, 18 (1-2): 11-14.

Johanson, H.W.; H.F. Robinson and R.E. Comstock (1955). Estimates of genetic and environmental variability in soybean. Agron. J. 47: 314-318.

Khattab, S.A.M. (1992). Genetic studies on some local and introduced genotypes of lentil. Ph. D. Thesis, Fac. of Agric, Ain Shams Univ, Cairo, Egypt.

Khattab, S.A.M. (1995). Performance and genetic parameters in some lentil genotypes under different water regimes. Egypt. J. of Agron., 20 (1-2):1-12.

Kishore, N. and P.V. Gupta (2002). Early generation in microspema-macrosperma derived gene pool of lentil. Indian J. Genetics and Plant Breed. 62 (1): 34-37.

Krarup, A.H. 1984. The effect of sowing dates and rates on lentil yield components. Lens Newsletter 11: 8-20

Kumar, Basant; K.L. Mehra and R.L. Sabra (1983). An investigation on correlation pattern among yield components in lentil. Lens Newsletter, 10 (2): 10-12.

Kumar-Sanjai, and G.C. Bajpai (1993). Comparison of association of lentil characters in normal and late sowing conditions. Lens Newsletter, 20 (1): 29-32.

Kusmenoglu, 1 and F.J. Muehlbauer (1998). Genetic variation for biomass and residue production in lentil. 1-Relation to agronomic traits. Crop Sci., 38 (4): 907-910.

Lakhani, J.P.; S. Holkar and R. Mishra (1986). Genetics of seedling vigor and hard seed lentil. Lens Newsletter, 13 (2): 10-12.

Lal, S. and N. Chandra (1978). Estimates of variability in lentils. Lens Newsletter, 5: 4-5.

Luthra, S.K. and P.C.S. Sharma (1990). Correlation and path analysis in lentils. Lens Newsletter, 17 (2): 5-8

Mahdy, E.E. and B.R. Bakheit (1988). Single plant selection in a landrace of lentil in Egypt. Lens Newsletter, 15: 3-6.

Malhotra, R.S.; K.B. Singh and J.K.Singh, (1974). Genetic variability and genotype-environmental interaction studies in lentil. J. Res. Punjab Agric. Univ. 10 (1): 17-21.

Manara, N.T.F. and W. Manara (1988). Morphological and development trait association in lentils. Lens Newsletter, 5 (1): 17-36.

Mia, M.W..; M.A.K. Mian and M.M. Rahman (1986). Performance of exotic lentil germplasm in Bangladesh. Lens Newsletter, 13 (2): 12-13.

Miller, P.A.; J.C. Williams and H.F. Robison (1959). Variety x environment interactions in cotton variety tests and their implications on testing methods. Agron. J. 51: 132-134.

Mohamed, S.I.A.; S.H. Salih and F.A. Salih (1989). Performance of lentil genotypes in Sudan. Lens Newsletter, 16 (2): 10-12.

Muehlbauer, F.J. (1974). Seed yield components in Lentils. Crop Sci. 14: 403-406.

Murari, k; S.L. Pandey and V. Kumar (1988). Simple correlation and multiple regression studies in Lentil. Legume Res., 11(2): 101-102.

Nandan, R. and B.P. Pandya (1980). Correlation, path coefficient and selection indices in Lentil. Indian J. Genet., 40(2): 399-404.

Nazeem, H.R.; A.M. Hassan; H.S. Sherifi; I.I.I. El-Shawaf and M.M. El-Hady (1983). Inheritance of some economic characters in Lentil. The 8th International Congress for Statistics Computer Science. Social and Demographic Research, Ain-Shams Univ., Egypt, March 26-31.

Nazeem, H.R.; I.I.I. El- Shawaf; A.M. Hassan; H.S. Sherif and M.M. El-Hady (1984). Inheritance of grain yield and some related characters in lentils (*Lens culinaris* Med.). The 9th International Congress for Statistics, Computer Science, Social and Demographic Research, Ain-Shams Univ., Egypt, 31 March-5 April.

Om, Vir. and V.P. Gupta (2001). Associations among yield and yield contributing characters in *Microsperma* x *Macrosperma* derivatives of lentil. **:** Crop improvement, 28 (1): 75-80.

Om, Vir; V.P. Gupta; O.P.S. Rathi and O. Vir (1998). Influence of nitrogen on the parameters of variability in *macrosperma* x