YIELD POTENTIAL OF SOME LENTIL GENOTYPES UNDER SALINITY CONDITIONS IN NORTH EGYPT

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Abstract

The aims of this study were to evaluate 20 lentil genotypes for their performance and yield potential under salinity conditions in north Egypt, and to estimate the genetic parameters, which help for further selection. The genotypes were planted in medium-saline soil (EC = 2976 ppm) at Tag El-Ezz research station, Dakahlya, in October and November in two seasons of 2001/2002 and 2002/2003. Significant differences occurred among seasons due to the variation in weather conditions, which affected yield and performance of genotypes. The genotype ILL 558 x Precoz gave the highest significant seed yield overall genotypes of 4.15 ardab/fed, with an increase of 49.2% over the yield of Giza 9. The genotypes Sinai 1, Giza 51, Giza 9, ILL 6829 and ILL 7163 gave also relatively high seed yield/fed, which ranged from 3.08 ardab/fed for Sinai 1 to 2.63 ardab/fed for ILL 7163 with out insignificant differences among them. Giza 51 combined high seed and straw yields. These promising genotypes could be recommended for planting in saline soil in north Egypt after conducting verification and large-scale trials. High estimates of phenotypic coefficient of variation, broad sense heritability together with genetic advance for seed yield/plant, suggesting that pronounced progress could be expected from selection among genotypes for yield character in saline conditions in north Egypt.

INTRODUCTION

Lentil (*Lens culinaris* Medikus) is an old and a traditional crop in Egypt. Despite its small annual cultivated area (about 5000 feddan), it is planted in 14 Governorates (Anonymous, 2003). Thus the crop grows under various environmental conditions in both north and south Egypt, such as in irrigated clay soil in old lands of the Nile Valley, in newly reclaimed irrigated sandy soil lands outreach Nile valley and in rainfed region in the north coast. In the north, soil salinity is common in some lands, for example the soil salinity level at El-Hamoul district in Kafr El-Sheikh Governorate ranged from 1.8 to

5.5 EC (Gomaa, 1998). Because lentil is known as a sensitive crop to salinity (Ashraf and Waheed, 1990; Ashraf, 1993), small areas are grown in Dakahlia, Kafr El-Sheikh and Damitta Governorates, where soil salinity conditions are common. The average cultivated area of lentil in these Governorates in 1997/98-2002/2003 represented only 2.31% of the total crop area allover the country. In comparison lentil area at Sharkia Governorate was 11% of the total crop area allover the country in the same period. Also, seed yield/feddan in the former Governorates was 7.5% less than the average seed yield in other Delta Governorates (Anonymous, 1998-2003).

Soil salinity is a major obstacle to crop production in arid and semi-arid regions of the world. Although many curative measures and management practices have been recommended to render salt-affected soils fit for crop production, the alternative biological approach has been considered an economical, feasible and efficient means of overcoming salinity problems. Much attention has been focussed on selection and breeding for salinity tolerance in the last few decades. Considerable efforts are being made to improve the salt tolerance of crops by selection and breeding (Al-Khatib *et. al*, 1994; Ashraf, 1994; Ashraf and Waheed, 1998). The estimates of narrow-and broad-sense heritability were high in lentil grown under saline conditions, indicating potential for improvement to salinity tolerance through selection and breeding (Ashraf and Waheed, 1998). In addition, the available genetic information from lentil salinity tolerance programs indicated that both additive and non-additive effects were significant with the prevalence of additive gene action over dominance for both yield and yield components (Ashraf and Waheed, 1998). Although there were different sets of genes of various degrees of dominance controlling salt tolerance in lentil, the dominance in most cases was controlled by recessive genes. In another study, 133-lentil accession was screened for salt tolerance. High estimates of broad sense heritability were obtained for percentage and rate of seed germination and seedling shoot dry matter, indicating that considerable improvement in salt tolerance in lentil is possible through appropriate selection and breeding methods (Ashraf, 1993).

To grow lentil successfully in a saline soil, evaluation of genotypes should be made to identify the promising genotypes to be grown in this condition. Therefore the objective of this study was to evaluate yield potential of 20 lentil genotypes under salinity conditions to identify salt-tolerant lentil genotypes and to determine the genetic components of variation for various characters which may help for selection at salt affected soils in North Egypt.

MATERIALS AND METHODS

Twenty lentil genotypes varied in their origin and characteristics were randomly chosen from lentil germplasm collection at Agricultural Research Center, Giza. The genotypes were grown at the Experimental Farm of Tag El-Ezz Research Station, Dakahlya Governorate in the two-winter seasons 2001/2002, and 2002/2003. Dates of planting were 29 October and 2nd November in the first and the second seasons. The results of soil chemical analysis in the experimental site are given in Table (1). Fertilizers at 15kg N and 25kg P_2O_5/feddan were applied to the soil before planting. A randomized complete block design with 4 replicates was used. Each experimental plot consisted of 4 rows, 3-m long and 30 cm apart with a plant density of 300 plants/m^2. Flooding irrigation system was used. Three irrigations were applied at planting, month and two months after planting. Days to 90% maturity were recorded. At harvest, 20 individual plants were randomly chosen from the central area of each plot to record and estimate plant height (cm), number of branches/plant, seed yield/plant, and number of pods/plant. The remaining plants in each plot were hand-pulled, air-dried, weighed, then threshed by hand from which seed and straw yields/fed, as well as 100-seed weight were estimated.

The analysis of variance was made separately for each season then a combined analysis for the two seasons was calculated (Gomez and Gomez, 1984). Estimates of phenotypic and genotypic coefficient of variation were calculated after Burton (1952). Heritability in broad sense was calculated according to Allard (1960). Expected genetic advance was estimated by the method suggested by Johnson *et. al* (1955).

RESULTS AND DISCUSSION

Soil analysis and level of soil salinity:

The soil analysis presented in Table (1) showed that soil content of soluble cations: Sodium (Na^+), Potassium (K^+), Calcium (Ca^{++}) and Manganese (Mg^{++}) and soluble anions (HCO_3, CL^-, and SO_4) were high. The salinity level as indicated by EC reaches 2976 ppm (EC = 4.65), indicating that the soil tended to be saline. According to the classification of soil salinity (US salinity Laboratory staff, 1954), the soil in experimental site at Tag El-Ezz is considered medium-saline (Table, 1). The level of soil salinity obtained was within the range of soil salinity at El-Hamoul district, Kafr El-Sheikh in north Egypt, which ranged from 1.8 to 5.5 EC (Gomaa, 1998).

Seasonal effects:

The analysis of variance revealed highly significant differences among seasons for plant height, seed yield (ardab/fed), straw yield (t/fed) and days to 90% maturity, indicating the importance of seasonal effects on these characters. The overall mean of seed yield in 2001/2002 was 2.87 ardab/fed,(one ardabs 160 kg), while the corresponding yield in 2002/2003 season recorded 1.71 ardab/fed (Table 2). The second season was warmer than the first season during vegetative growth stage (November-January), where the average monthly maximum temperature in these three months in the second season reached 28.1, 23.2 and 23.5°C, respectively. The corresponding temperatures in the first season were 25.4, 20.9 and 17.2°C. In contrast, the first season was warmer than the second season during flowering and pod-filling stages in Feb-March, where the average monthly maximum temperatures in these two months were 21.1 and 25°C in the first season and 19.8, 22.7°C in the second season, respectively. It seems that accumulation of dry matter was higher at pod-filling stage in the first season comparing with the second season, reflecting the higher number of pods formed per plant in the first season (Table, 2).

Mean days to 90% maturity in the first season was 2.1 days shorter than that of the second season (Table, 2). Also, relatively shorter plants were observed in the first season (33.30cm) comparing to the second season (37.85cm). The seasonal weather conditions also affected both seed and straw yields/feddan. The average seed yield/fed was 2.87 and 1.71 ardab in the first and second seasons, respectively. Several researchers have reported seasonal effects on lentil characters (Hamdi, 1987; Hamdi *et. al*, 2002-a).

Performance of genotypes:

The combined analysis of variance (not tabulated) indicated highly significant differences among genotypes for all studied characters. Also the genotype x season interaction had a significant effect on all studied characters, except days to maturity. Large genotype x season interaction is common in variety trials. As an example, Hamdi (1987) found the genotype x year component was more than three times as large as the genotype x location interaction component in lentil, because year effect includes fluctuation in weather conditions. Therefore it is important to test a set of genotypes in a series of seasons to obtain more information about breeding materials.

Phenological and morphological characters:

The average performance of plant height, number of branches/plant and days to 90% maturity for each genotype over seasons are given in Table (3). Plant height ranged from 27.81 cm for L 318 to 44.09 cm for line (ILL 558 x Precoz). Number of branches/plant ranged from 4.31 branches for Giza 370 to 6.65 branches for line (ILL 558 x Precoz). The values of plant height and number of branches/plant in Table (3) showed that their lie within the ranges of characters for lentil growing in non-saline soil conditions (Hamdi and Ezatt, 1998). Narrow ranges between genotypes was obtained for days to maturity, however it is clear that the genotype Sinai 1 was the earliest in maturity with an over all mean of 132.8 days. Earliness in maturity of Sinai 1 was previously reported (Hamdi *et. al*, 2002-b).

Yield and yield component characters:

Average seed yield/plant, number of pods/plant, 100- seed weight, seed and straw yields/feddan are presented in Table (4). The genotypes line (ILL 558 x Precoz) and Giza 51 showed the highest seed yield/plant of 2.25 and 2.24 g, respectively, with insignificant differences between them. Yield increases of these genotypes over the check variety Giza 9 were 66.7 and 65.9%, respectively. High seed yield/plant of these genotypes was mainly due to their high number of pods. The range of 100-seed weight was from 2.41g for ILL 6461 to 3.60 g for Sinai 1. Concerning seed yield/feddan, the line (ILL 558 x Precoz) out yielded all tested genotypes, recording 4.15 ardab/fed, with an increase of 49.2% over the yield of Giza 9. The genotypes Sinai 1, Giza 51, Giza 9, ILL 6829 and ILL 7163 gave also relatively high seed yield/fed, which ranged from 3.08 ardab/fed for Sinai 1 to 2.63 ardab/fed for ILL 7163 with insignificant differences among them (Table, 4). Giza 51combined high seed and straw yields as its straw yield ranked the third highest among all genotypes. Hence these genotypes are promising and could be recommended for planting in saline soil in north Egypt after conducting verification and large-scale trials to confirm the obtained results.

There are some genotypes showing superiority in some characters and should be exploited in breeding programs. For example, Sinai 1 ranked the second in terms of productivity and the earliest in maturity, hence it could be recommended for planting in such saline environment due to its tolerance and early maturity to save water. On the other hand, hybridization between the promising line (ILL 558, Precoz), Sinai 1, Giza 51, Giza 9 and ILL 6829 could be useful to select early maturing and high yielding materials for saline environments.

Genetic parameters of the studied characters:

Estimates of phenotypic coefficients of variation (PCV), genotypic coefficients of variation (GCV), broad sense heritability ($h^2_{b.s.}$) and genetic advance as percentage of mean for studied characters are presented in Table (5). The highest (PCV) was observed for seed yield/plant (37.36), straw yield/fed (32.29) and number of pods/plant (28.59), indicating the possibility of effective selection for these traits. However, seed yield/plant combined the highest estimates of both PCV and GCV. High heritability estimates were obtained also in seed yield/plant (80.07%) and days to 90% maturity (80.87%). Hence the expected genetic advance was high for seed yield/plant (61.67%). Ezzat and Ashmawy (1999) also reported high broad sense heritability for days to maturity in lentil.

Johnson *et. al* (1955) stated that heritability estimates together with genetic advance are more important than heritability alone to predict the effect of selecting the best individuals. Therefore, pronounced progress should be expected from selection among genotypes for seed yield/plant under salinity conditions. Similar results were found by Ashraf and Waheed (1998), who detected high estimates of narrow-and broad-sense heritability for yield, indicating potentiality for improvement to salinity tolerance in lentil.

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Table 1. Mechanical and chemical analysis of the soil at Tag El-Ezz research station in Dakahlia governorate.

Analysis	Value	Analysis	Value
Mechanical analysis:		Soluble cations (mg/100 g soil):	
- Course Sand %	1.60	- Na^+	14.0
- Fine Sand %	7.01	- K^+	0.23
- Silt %	39.23	- Ca^{++}	13.08
- Clay%	44.10	- Mg^{++}	7.17
- Soil Texture	Silty clay		
		Soluble anions (mg/100 g soil):	
		- HCO_3	0.52
Organic Carbon %	2.23	- CL^-	18.56
Total Nitrogen %	0.11	- SO_4.	23.42
C/N ratio	20.13	EC (ppm)	2976
		EC *	4.65

Classification of soil salinity according to United States Salinity Laboratory Staff (1954):

1-EC less than 1280 ppm (salinity free). 2- EC = 2240 - 4160 ppm (medium salinity).
3-EC = 1280 - 2240 ppm (low salinity). 4- EC higher than 4160 ppm (high salinity).

Table 2.Averages of the studied characters for 20 lentil genotypes evaluated under saline soil conditions at Tag El-Ezz, Dakahlia, in 2001/2002 and 2002/2003 seasons.

Character	2001/2002	2002/2003	Significance+
Plant height (cm)	33.31	37.85	**
No. of branches/plant	5.60	5.26	NS
Seed yield/plant (g)	1.24	1.19	NS
No. of pods/plant	40.42	32.51	NS
100-seed weight (g)	3.07	2.93	NS
Seed yield (ardab/fed)	2.87	1.71	**
Straw yield (t/fed)	0.97	1.84	**
Days to 90% maturity	143.84	145.96	**

+ Between data of both seasons (from ANOVA).

Table 3. Average plant height, number of branches/plant at harvest and days to90% maturity for 20lentil genotypes evaluated under saline conditions at Tag El-Ezz, Dakahlia, in 2001/2002 and 2002/2003 seasons.

Genotype	Plant height (cm)	No. of branches/ Plant	Days to 90% maturity
Giza 9	43.14	5.93	152.0
Giza 370	33.54	4.31	138.0
Giza 4	33.74	4.60	145.3
Giza 51	41.76	6.06	147.0
Sinai 1	33.96	5.74	132.8
ILL 5782	36.14	5.41	140.5
L 318	27.81	4.61	141.0
ILL 7706	31.39	6.31	148.8
ILL 6829	33.06	5.36	160.3
ILL 5993	37.66	4.86	152.0
ILL 6458	27.84	5.24	145.3
ILL 6461	35.64	5.69	145.3
ILL 7556	30.84	5.56	137.8
Line (ILL 5722 x ILL 5728)	34.76	4.88	150.8
ILL 7975	34.59	5.54	151.5
ILL 7616	33.61	6.43	141.5
ILL 7724	36.14	4.76	140.3
Line (ILL 558 x Precoz)	44.09	6.65	146.5
ILL 7163	43.19	4.75	145.3
Line (Fam. 300 x Precoz)	38.68	5.89	136.5
Range	27.8-44.1	4.3-6.7	132.8-160.3
Over all mean	35.58	5.43	144.90
LSD at 0.05	3.101	0.856	3.162

Table 4. Average seed yield/plant, number of pods/plant, 100-seed weight, seed and straw yields per feddan for 20 lentil genotypes evaluated under saline soil conditions at Tag El-Ezz, Dakahlia, in 2001/2002 and 2002/2003 seasons (combined data).

Genotype	Seed yield/ plant (g)	No. of pods/plant	100-seed weight (g)	Seed yield ardab/fed	Straw yield t/fed.
Giza 9	1.35	30.99	2.85	2.78	1.45
Giza 370	1.20	21.76	3.39	2.20	1.41
Giza 4	0.87	30.21	3.01	2.44	2.30
Giza 51	2.24	50.01	2.43	2.97	2.03
Sinai 1	1.40	25.46	3.60	3.08	1.16
ILL 5782	1.10	27.11	3.16	2.16	1.18
L 318	0.82	21.12	3.01	1.61	1.25
ILL 7706	0.73	37.66	3.10	2.37	1.63
ILL 6829	0.92	33.44	3.31	2.64	1.94
ILL 5993	1.01	31.86	3.23	2.38	2.13
ILL 6458	0.75	29.84	3.20	2.19	0.73
ILL 6461	1.10	51.83	2.41	1.89	0.66
ILL 7556	1.13	33.99	3.04	0.85	0.91
Line (ILL 5722 x ILL 5728)	1.13	31.04	2.90	1.59	0.63
ILL 7975	1.57	43.73	2.85	2.06	2.00
ILL 7616	0.70	41.96	3.01	1.96	1.34
ILL 7724	0.93	41.81	2.55	1.85	0.90
Line (ILL 558 x Precoz)	2.25	58.33	2.88	4.15	1.53
ILL 7163	1.72	45.32	2.98	2.63	1.24
Line (Fam. 300 x Precoz)	1.37	41.77	3.18	1.98	1.69
Range	0.70-2.3	21.1-58.3	2.4-3.6	0.85-4.15	0.63-2.3
Over all mean	1.21	36.46	3.00	2.29	1.40
LSD at 0.05	0.200	10.041	0.235	0.513	0.397

Table 5. Phenotypic (PCV) and genotypic (GCV) coefficient of variations, heritability in broad sense ($h^2_{b.s.}$), and genetic advance as percentage of the mean (GA %) for studied characters of lentil genotypes evaluated at Tag El-Ezz, Dakahlia, in 2001/2002 and 2002/2003 seasons (combined data).

Character	PCV %	GCV %	$h^2_{b.s}$	GA%
Plant height (cm)	12.23	8.49	48.19	12.14
No. of branches/plant	15.49	0.0	0.0	-
Seed yield/plant (g)	37.36	33.43	80.07	61.67
No. of pods/plant	28.59	6.60	5.33	3.14
100-seed weight (g)	10.21	6.50	40.51	8.52
Seed yield (ardab/fed)	29.20	18.48	40.03	10.52
Straw yield (t/fed)	32.29	15.03	21.66	14.40
Days to 90% maturity	5.04	4.53	80.87	8.39

إنتاجية بعض التراكيب الوراثية للعدس تحت ظروف الملوحة في شمال مصر

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استهدفت هذه الدراسة تقييم أداء ٢٠ تركيب وراثى لمحصول العدس للوقوف على قدرتها الإنتاجية تحت ظروف الأراضى الملحية فى شمال الدلتا ، وتحديد المعايير الوراثية التى تساعد فى انتخاب سلالات عالية الإنتاج تحت هذه الظروف ، وقد تم زراعة التراكيب الوراثية فى ارض متوسطة الملوحة (٢٩٧٦جزء فى المليون) وذلك يوم ٢٩ اكتوبر ٢٠٠٢/٢٠٠١ والثانى من نوفمبر ٢٠٠٣/٢٠٠٢ .

وقد أظهرت النتائج وجود اختلافات معنوية بين موسمى الزراعة ويعزى ذلك إلى الاختلاف فى الظروف الجوية التى أثرت على إنتاجية التراكيب المختبرة ، وقد أنتج الهجن (سلالة ٥٥٨ X بريكوز) أعلا محصول بذور للفدان ومقداره ٤,١٥ إردب/فدان متفوقاً بنسبة ٤٩,٢% على صنف المقارنة جيزه ٩، هذا وقد أظهرت بعض التراكيب الوراثية إنتاجية مرتفعة نسبياً وهى سيناء ١ إلى ٢,٦٣ إردب للفدان للسلاله ٧١٦٣، وقد جمع الصنف جيزة ٥١ بين محصولى بذور وقش عاليين ، وبناء على ذلك يمكن التوصية بزراعة هذه التراكيب الوراثية المبشرة فى الأراضى متوسطة الملوحة فى شمال الدلتا، وذلك بعد إجراء التجارب التأكيدية والتجارب الموسعة فى حقول المزارعين .أوضحت النتائج أيضاً أن صفة وزن بذور النبات قد حققت أعلا التقديرات لمعامل التباين المظهرى ونسبة التوريث والتقدم الوراثى المتوقع من الانتخاب ، لذلك فإنه من المتوقع الحصول على تقدم ملحوظ لهذة الصفة تحت ظروف الملوحة إذا تم الانتخاب بين سلالات العدس المزروعة .