تقييم أداء بعض السلالات المدخلة من العدس (*Lens culinaris* Medik.) تحت ظروف الزراعة المطرية

Evaluation of some Lentil Lines (*Lens culinaris* Medik.) Performance under Rainfed Conditions

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الملخّص

نُفذ البحث في مزرعة أبي جرش في كلية الزراعة بجامعة دمشق (سورية) خلال فصل الشتاء للموسم الزراعي 2015/2014، بهدف تقييم أداء تسع سلالات مدخلة من العدس (L-55001، L-55002، L-55003، L-55017، L-55018، L-55020، L-55035، L-55051، L-55118)، تمّ الحصول عليها من الهيئة العامة للبحوث العلمية الزراعية في سورية إضافة لصنف الشاهد (إدلب -2) تحت ظروف الزراعة المطرية، وُضعت التجربة وفق تصميم القطاعات كاملة العشوائية، في أربعة مكررات.

أشارت نتائج البحث إلى وجود تباين وراثي واضح في استجابة سلالات العدس المدروسة تحت ظروف الزراعة المطرية في معظم الصفات الفينولوجية والفيزيولوجية والإنتاجية، وسجل الصنف الشاهد إدلب -2 معنوياً أقل عدد أيام للإنبات (13.85 يوماً)، والإزهار (85.20 يوماً)، ووصل لمرحلة النضج التام بعد 126.25 يوماً، وأعلى قيم لصفات ارتفاع النبات (21.56 سم)، وعدد القرون والبذور في النبات، ووزن 100بذرة (9.60 قرناً.النبات$^{-1}$، 41.70 بذرة.النبات$^{-1}$ و16.28 غ على التوالي)، تلاه السلالة L-55051 (8.70 قرن.النبات$^{-1}$، 38.60 بذرة.النبات1- على التوالي) والسلالة L-55002 في وزن الـ 100 بذرة (13.64 غ)، بينما سجلت السلالة L-55051 معنوياً أعلى محتوى ماء نسبي وبرولين في الأوراق (61.26 % و4.66 مغ.غ$^{-1}$ على التوالي)، تلتها السلالة L-55118 (59.77 % و 4.37 مغ.غ$^{-1}$ على التوالي)، كما حقق الصنف إدلب2- معنوياً أعلى غلة من البذور والقش (8.74 و16.43 غ.النبات$^{-1}$)، تلاه السلالة L-55051 (8.52 و 15.64 غ، النبات$^{-1}$ على التوالي).

يُستنتج أنّه يمكن استخدام الصنف المحلي إدلب -2 والسلالتين L-55051 و L-55118 كآباء في برامج تربية وتحسين محصول العدس تحت ظروف الزراعة المطرية.

الكلمات المفتاحية: العدس، صفات فيزيولوجية، الشكل المظهري، الغلة ومكوناتها، زراعة مطرية.

Abstract

This investigation was carried out in Abu Jarash farm, faculty of agriculture, Damascus University (Syria) during 2014/2015 winter season, to evaluate the performance of ten lentil genotypes; nine lines (L-55001, L-55002, L-55003, L-55017, L-55018, L-55020, L-55035, L-55051, L-55118) introduced from General Commission for Scientific Agricultural Research

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in Syria in addition to the check variety (Edlib-2) under rainfed conditions. The experiment was laid out according to randomized complete block design (RCBD) with four replicates.
Results showed that most of the phenological, physiological and productivity the traits of lentil lines had different responses under rainfed conditions, due to genotypes genetic variation. The check variety Edlib-2 recorded significant differences and had the lowest values for the following traits; germination date (13.85 days) and flowering date (85.20 days) and reached to maturity after 126.25 days, the highest mean of the following traits; plant height (21.56 cm), number of pods and seeds per plant , 100-seeds weight (9.60 pods.plant^{-1}, 41.70 seeds.plant^{-1} and 16.28 g respectively), and followed by the line L-55051 (8.70 pods. plant-1and 38.60 seeds.plant-1 respectively) and the line L-55002 in 100-seeds weight (13.64 g). Meanwhile, the line L-55051 recorded significantly the highest values for relative water content and proline content (61.26% and 4.66 mg.g^{-1} respectively) and followed by the line L-55118 (59.77% and 4.37 mg.g^{-1} respectively). The check variety Edlib-2 achieved significantly the highest seed and straw yield (8.74 and 16.43 g.plant-1) followed by the line L-55051 (8.52 and 15.64 g. plant^{-1}). The local cultivar Edlib-2 and the two lines L-55051 and L-55118 could be used as a genetic material for the improvement of lentil crop under drought conditions.
Keywords: Lentil, Physiological Traits, Yield and its Components, Rainfed Conditions.

Introduction

Lentil (*Lens culinaris* Medik.) considered as one of the most important legume crops in rainfed cropping systems and tolerant crop to water stress (Sarker *et al*., 2003). Water scarcity is the major problem around the world. Drought stress is the major limiting factor on plant growth and yield (Yordanov *et al*., 2000). Moderate to severe drought stress could reduce plant biomass, harvest index and grain yield (Ramirez-Vallejo and Kelly, 1998). Water shortage is one of environmental factors which limited plant growth and crop productivity particularly in arid regions (Soriano *et al*., 2004; Sinclair, 2005).

Exposing the plants to water stress during vegetative stage had the greatest effects on plant height and biomass (Ghassemi-Golezani and Mazloomi-Oskooyi, 2008). Soil water deficits which occurred during the reproductive growth had the most adverse effect on crop yield (Costa-Franca *et al*., 2000; Ghassemi-Golezani *et al*., 2010).The effect of water limitation on plant growth would observed during the following; phenological responses, morphological adaptations, physiological changes and biochemical adaptations. Plant reactions could be affected by soil water content directly and/or indirectly. The most of physiological processes in plants as well as photosynthesis, transpiration, cell turgidity and cell growth were directly affected by relative water content (Sarker *et al*., 2005). Herbinger *et al*. (2002) considered that Relative Water Content (RWC) expressed water status in plants, which decreased 45-88% under drought conditions. Tolerant cultivars had the highest values of RWC compared with sensitive cultivars.

An experiment carried out in Pakistan to study seed yield and its components of 20 lentil genotypes under water stress and normal irrigated conditions, results showed that seed yield, number of seeds per plant and number of pods per plant were the most sensitive traits to drought stress comparing

to1000 seeds weight trait. While, harvest index, biological yield, number of seeds and number of pods per plant were had positive and significant correlation with seed yield per hectare (Mohammad Salehi *et al*., 2008). Turner *et al*., (1996) reported that lentil has considerable osmotic adjustment by control cell osmotic adjustment and maintaining turgor potential which allow stomata opening and cell expansion which support photosynthesis process and organic matter production..ween yield, yield components and morpho-physiological characteristics under rainfed conditions, and found that significant differences for all characters under study; plant height, number of seeds per plant, leaf area, biological yield, number of pods per plant and 1000-seed weight which considered as yield components, hence selection for these traits leads to yield improvement.

In the present study, the major aims were investigated the response of lentil genotypes to drought stress and identify characters that can be used for enhncing yield and its components under arid and semiarid conditions.

Materials and Methods

A field experiment was conducted at Abu Jarash farm, faculty of agriculture, Damascus university (Syria), during 2014/2015 winter season to study the performance of nine lines of lentil crops (L-55001, L-55002, L-55003, L-55017, L-55018, L-55020, L-55035, L-55051, L-55118) introduced from General Commission for Scientific Agricultural Research in Syria, in addition to the check variety (Edlib-2) under rainfed conditions. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replicates. The previous crop was wheat during the winter season of 2013/2014. Seed bed was prepared by the application of all agricultural operations, soil ploughed three times before growing lentil lines to control weeds. The experimental site was divided into 30 plots, recommended fertilizers dose (30:60:80 kg NPK/ha) were added. Seeds of lentil genotypes were treated with rhizobia bacteria (*Rhizobium leguminosarum*) befor sowing and grown during the first week of December on raws with a spacing of 30 cm between and 10 cm within raws, each of experimental plot size (2.4 m × 2 m).

The soil of the experimental site texture was loamy, slightly alkaline (pH 8.6), low nitrogen content (186.43 kg.ha^{-1}), medium phosphorus content (32.55 kg.ha^{-1}), potassium content (193.25 kg.ha^{-1}), and medium in organic matter content (2.30%) (Table 1).

Table 1. The soil physical and chemical properties in the experiment site.

Indicator	Physical properties			Chemical properties				
	Sand (%)	Silt (%)	Clay (%)	N (kg.ha^{-1})	P_2O_5 (kg.ha^{-1})	K_2O (kg.ha^{-1})	pH	OM* (%)
Value	43.28	33.10	23.62	186.43	32.55	193.25	8.6	2.30

*OM:Organic matter

The total rainfall received during the growing season of 2014-2015 was 265.10 mm (Table 2). Observations on phonological, physiological and productivity characters; germination date (days), flowering date (days), maturity date (days), plant height (cm), relative water content (%), proline

content ($mg.g^{-1}$), number of pods per plant, number of seeds per plant, 100-seed weight (g), seed yield per plant ($g.plant^{-1}$), straw yield per plant ($g.plant^{-1}$) were recorded. Then the data were subjected to statistical analysis by using MSTAT-C programme. L.S.D. test was used to verify the significance of mean performances for all traits recorded at 5% level.

Table 2. The distribution of rainfall during the growing season 2014/ 2015.

Month	Nov.	Dec.	Jan.	Feb.	March	April	May	Total
Rainfall (mm)	18.0	56.0	90.5	15.0	85.0	0.5	0.0	265

Results and Discussion

Phenological traits:

Results in table (3) clearly indicated that there were issignificant differences among lentil genotypes in germination, flowering and maturity dates. The genotype Edlib-2 significantly recorded the lowest values of germination date (13.85 days) and flowering date (85.20 days), followed by the three lines L-55001, L-55017 and L-55051 in the germination date (17.65,15.95 and 17.90 days respectively) and the two lines L-55001 and L-55002 in flowering date (86.50 and 87.25 days, respectivly), whereas the 7 lines recorded the lowest number of days to maturity, while Edlib-2 genotype recorded the highest number of days to maturity (126.25 days). These results showed that genetic variation among lentil genotypes for phonological characters had important impact for identifying tolerant genotypes under drought stress, these results in agreement with the findings of Mohammad Salehi *et al*. (2008).

Table 3. Response of phonological traits for lentil genotypes under rainfed conditios.

Genotypes	Phenological traits		
	Germination date (days)	Flowering date (days)	Maturity date (days)
L-55001	17.65^{efgh}	86.50^{ghij}	111.50^{defgh}
L-55002	18.80^{de}	87.25^{ghi}	112.80^{cdefg}
L-55003	22.85^{bcd}	88.50^{fgh}	114.25^{cde}
L-55017	15.95^{efghi}	93.20^{abce}	116.25^{c}
L-55018	26.50^{ab}	91.60^{bcef}	112.80^{cdefg}
L-55020	25.25^{abc}	93.85^{ab}	113.45^{cdef}
L-55035	27.40^{a}	93.65^{abc}	121.40^{b}
L-55051	17.90^{efg}	95.40^{a}	115.80^{cd}
L-55118	18.10^{ef}	90.80^{bcefg}	111.65^{defg}
Edlib-2	13.85^{hij}	85.20^{hijk}	126.25^{a}
Mean	20.43	90.60	115.62
$LSD_{0.05}$	4.15	3.20	4.36
C.V(%)	12.60	2.241	7.27

*Similar letters in same column indicate no significant differences between means.

Morphological and physiological traits:

The data in table (4) clearly showed that significant differences among lentil genotypes in plant height, relative water content and proline content. The genotype Edlib-2 had higher values for plant height (21.56 cm), followed by the two lines L-55118 and L-55035 (15.65 and 14.52 cm), whereas the line L-55051 recorded the highest values for relative water content and proline content (61.26% and 4.66 mg.g^{-1} respectively) followed by the line L-55118 content (59.77% and 4.37 mg.g^{-1} respectively). The results indicated that the line L-55051 was more tolerant to drought stress. Tolerant genotypes had higher values of RWC compared with sensitive cultivars (Herbinger *et al*., 2002). Turner *et al*. (1996) reported that lentil is more tolerant to drought due to its ability for cell osmotic adjustment and maintaining turgor potential, carbohydrates and amino acids especially proline.

Table 4. Response of morphological and physiological traits for lentil genotypes under rainfed conditions.

Genotypes	Morphological and physiological traits		
	Plant height (cm)	Relative water content (%)	Proline content (mg.g^{-1} fresh weight)
L-55001	10.24^{fg}	50.36^{hi}	2.25^{ij}
L-55002	8.35^{hij}	53.27^{efg}	3.35^{fg}
L-55003	9.16^{fgh}	54.28^{de}	3.47^{ef}
L-55017	12.48^{d}	56.14^{cd}	3.88^{c}
L-55018	8.83^{hi}	50.28^{hij}	2.59^{hi}
L-55020	10.54^{f}	52.63^{fgh}	2.64^{h}
L-55035	14.52^{bc}	57.72^{bc}	3.73^{ce}
L-55051	12.41^{de}	61.26^{a}	4.66^{a}
L-55118	15.65^{b}	59.77^{ab}	4.37^{ab}
Edlib-2	21.56^{a}	53.48^{ef}	3.88^{c}
Mean	12.37	54.92	3.26
LSD$_{0.05}$	1.43	2.35	0.28
C.V(%)	5.64	6.36	9.53

***Similar letters in same column indicate no significant differences between means.**

Quantitative and yield traits:

Results in the table (5) represented that significant differences among lentil genotypes for the following traits; number of pods per plant, number of seeds per plant and 100 seed weight (g). The genotype Edlib-2 recorded higher values for number of pods per plant (9.60), number of seeds per plant (41.70) and 100 seed weight (16.28 g) followed by the lines L-55002, L-55017, L-55118 and L-55051 with no significant difference for number of pods per plant (6.50, 6.80, 8.70 and 7.80 respectivley), the two lines L-55051 and L-55118 for number of seeds per plant (38.60

and 31.20 respectivley), and the three lines L-55017, L-55003 and L-55002 for 100 seeds weight (13.05, 13.56 and 13.64 grespectivley). The lowest number of pods and seeds per plant were registered with the line L-55020 (5.19 and 6.30 repectively). Whereas the lowest 100-seeds weight were recorded with the lines L-55018, L-55020 and L-55001 (9.08, 9.33 and 9.81 g respectively). The check variety (Edlib-2) exceed over other studied genotypes in number of pods per plant and number of seeds per plant under rainfed conditions, this might be due to maintaining higher relative water content and osmotic adjustment, these results in agreement with those findings of Moslem Abdipur *et al*. (2011).

Table 5. Number of pods per plant, number of seeds per plant and 100 seed weight for lentil genotypes under rainfed conditions.

Genotypes	Number of pods per plant	Number of seeds per plant	Weight of 100 seeds (g)
L-55001	6.20^{bcdefg}	8.20^{efgh}	9.81^{efgh}
L-55002	6.50^{bcde}	15.30^{def}	13.64^{ab}
L-55003	$5.21^{cdefghi}$	16.40^{de}	13.56^{abc}
L-55017	6.80^{abcd}	20.80^{cd}	13.05^{bcd}
L-55018	5.40^{cdefgh}	8.10^{efghi}	9.08^{efghij}
L-55020	$5.19^{cdefghij}$	6.30^{efghij}	9.33^{efghi}
L-55035	6.40^{bcdef}	12.20^{defg}	10.45^{bcdefg}
L-55051	8.70^{ab}	38.60^{ab}	11.32^{bcdef}
L-55118	7.80^{abc}	31.20^{abc}	11.76^{bcde}
Edlib-2	9.60^{a}	41.70^{a}	16.28^{a}
Mean	6.78	19.88	11.83
$LSD_{0.05}$	3.15	12.22	3.42
C.V(%)	11.65	15.28	13.21

***Similar letters in same column indicate no significant differences between means.**

Obtained results in table (6) showed significant differences among lentil genotypes in seed and straw yields per plant. The two genotypes Edlib-2 and L-55051 recorded the highest seed and straw yields per plant (8.74 and 8.52g.plant^{-1}) for seed yield and 16.43 and 15.64 g.plant^{-1} for staw yield respectively). The lowest seed and straw yields per plant were recorded by the lines L-55020, L-55018 and L-55001 (1.26, 1.62 and 1.64 g.plant^{-1} respectively) for seed yield (2.67, 3.20 and 3.12 g.plant^{-1} respectively) for straw yield. The local check variety Edlib-2 and line L-55051 recorded highest seed yield under rainfed conditions due to its higher yield components; number of pods per plant and number of seeds per plant. Moslem Abdipur *et al*., (2011) reported that number of seeds per plant and number of pods per plant were identified as important yield components, therefore we should focus on these traits for yield improvement in lentil, and the local cultivar Edlib-2 and line L-55051 considered as good parent for genetic improvement of lentil crop under drought conditions.

Table 6. Seed and straw yield per plant for lentil genotypes under rainfed conditions.

Genotypes	Seed yield (g.plant^{-1})	Straw yield (g.plant^{-1})
L-55001	1.64^{efgh}	3.12^{efghi}
L-55002	3.04^{def}	5.68^{def}
L-55003	3.28^{de}	6.16^{de}
L-55017	4.16^{cd}	7.86^{d}
L-55018	1.62^{efghi}	3.20^{efgh}
L-55020	1.26^{efghij}	2.67^{fghi}
L-55035	2.44^{defg}	4.58^{defg}
L-55051	8.52^{ab}	15.64^{ab}
L-55118	6.24^{c}	13.37^{abc}
Edlib-2	8.74^{a}	16.43^{a}
Mean	4.09	7.87
$LSD_{0.05}$	2.23	3.82
C.V(%)	7.60	6.73

***Similar letters in same column indicate no significant differences between means.**

Conclusions

- Significant genetic variations were recognized among studied lentil genotypes.
- The local cultivar Edlib-2 and the two lines L-55051 and L-55118 recorded significantly the highest values for one or more of the following traits; relative water content, proline content, number of pods per plant, number of seeds per plant and seed yield per plant under rainfed conditions.
- The local cultivar Edlib-2 and the two lines L-55051 and L-55118 could be used as genetic material for improvement of lentil crop under drought conditions.

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