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The Study of Seed Yield and Seed Yield Components of Lentil (*Lens culinaris* Medik) under Normal and Drought Stress Conditions

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Abstract: In this study yield and seed yield components of twenty lentil (*Lens culinaris* Medik) genotypes were compared in a split plot RCBD based design with 3 replications at the Zanjan University Research Farmland in 2004. The main plots were lentil planted under drought stress and non stress (irrigation) condition and subplots were twenty of genotype lentil. There were significant differences between traits in lentil genotypes. The seed yield per plant was sensitive to drought stress but 100 seed weight was more tolerance and stable trait in drought condition. As correlation analysis of traits in various stress condition, the harvest index, seed yield per plant, pods per plant and biological yield were correlated with grain yield. In addition harvest index, seed yield per plant, pods/plant and biological yield were the most important traits that have a relationship with grain yield.

Kay words: Water stress, Yield, Lentil, Yield component

INTRODUCTION

Lentil is an important component of the rain fed farming system of West Asia and Africa and source of high-quality protein for humans (Hamdi *et al*., 1992). Research indicated lentil seed yield increased with irrigation frequency and total water use (Salehi *et al*., 2006). There are strong linear relationships (r^2>0.90) between yield and moisture supply in lentil (Silim *et al*., 1993a). Supply sufficient water in irrigated and rainfed pea increased seed size, seed yield, biomass yield and harvest index (Singh and Saxena, 1990). Salehi *et al*. (2006) reported that the seedling and flowering stages were most sensitive to water availability and drought stress. However a deficiency of water during of any growth stages in legume species often result in a loss of seed yield. Captipon *et al*. (1988) reported intensive drought stress in dry season and strong wind in humid season reduced Mung bean seed yield. They suggested high seed yield has related pods size and number and resistance to pests and disease.

Drought tolerance or resistance in native plant species is often defined as survival, but in crop species it must be define in terms of productivity (Passioura, 1983). The general term 'drought tolerance' can be used to refer to several type of drought resistance, such as drought escape and dehydration tolerance or avoidance (Turner, 1979; Jones, 1993). In contrast to the cultivated germplasm, drought escape was relatively unimportant in wild lentil (Hamdi and Erskine, 1996). Levitt (1972) noted that drought resistance can be defined as: the water stress necessary to produce a specific plastic strain. The choice of parameters used to quantify the level of stress and the intensity of strain are some what arbitrary.

Hamdi (1996) reported genotypes 293, 234, ILL 6025, ILL 3715 and ILL 5821 were the most tolerant to dry conditions. In addition, the genotypes 270, 91, 273, 316, 300 and ILL 3693, 6025, 3715, 5782, 3490 showed general adaptability. Khattab (1995) found Heritability estimates were high for 100 seed weight, moderate for days to maturity and low for the remaining characters. He suggests, 100 seed weight, seeds per plant and pods per plant could be considered as selection criteria in lentil improvement if these traits proved to be highly correlated with yield. Salam and Islam (1994) reported M1-30, M1-52 and M1-563 had greater values for filled pods, yield per plant and harvest index under stress than L112. M1-596 had the greatest biomass production but the lowest seed yield in all conditions.

Hamdi *et al*. (1992) reported that the variation in mean seed yield per plant was largely explained (r^2 = 0.833) by the variation in water supply. Supplementary irrigations (50 mm each) resulted in a 20% increase in seed yield per plant. They suggested Genotypes ILL241,

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ILL5523 and ILL5527 were promising under irrigated conditions, ILL1983, ILL2501 and ILL2526 in dry conditions and ILL5737 was stable across a range of environments. Dantuma and Grashoff (1984) emphasized that selection should increase the harvest index and reduce excessive vegetative growth in favorable conditions.

Breeding for resistance to extremes of temperature and moisture in cool season food legumes is limited by the lack of adequate screening techniques. Development of new screening tests designed to select for specific adaptive traits require a better knowledge of the mechanisms of resistance in these crops, especially to drought (Wery *et al*., 1994). The aim of this investigation was to study of seed yield and yield component traits of Lentil (*Lens culinaris* Medik) under normal and drought stress and found out the most sensitive yield component of lentil in rainfed condition.

MATERIALS AND METHODS

Genotypes and environment: Twenty diverse genotypes, collected from 3 countries selected randomly from the ICARDA lentil germplasm collection (Table 1), were grown in Zanjan University Research Farm, Iran (latitude 31°37′N, longitude 48°49.5′, elevation 1633 m, EC of soil water by the equation in EC = 2.33) in 2004. Monthly rainfall and minimum air temperature during the growing seasons are shown in Table 2.

Experimental procedure: We used a split-plot design with three replications which the main plots were lentil planted under drought stress and non stress condition (irrigation in three times: before flowering, flowering and pod filling stage). The subplot factor were twenty genotypes of lentil (Table 1).

Table 1: Name and source of the 20 lentil tested

Genotype	Source
Flip-97-8	ICARDA
TN-1772	Iran-Zanjan
TN- 1778	Iran-Zanjan
TN-1751	Iran-Zanjan
TN-1768	Iran-Zanjan
ILL-6439	ICARDA
ILL-7135	ICARDA
Cabralia inta	Argentina
IIL-6030	ICARDA
Flip-82-1L	ICARDA
TN-1758	Iran-Zanjan
ILL-590	ICARDA
Flip-85-71	ICARDA
TN-1758	Iran-Zanjan
TN-1756	Iran-Zanjan
ILL-6002	ICARDA
TN-1773	Iran-Zanjan
GAZVEN	Dry Land Farming Res. Center
ZIBA	Dry Land Farming Res. Center
GAJSARAN	Dry Land Farming Res. Center

ICARDA germplasm accession number; ILL International Legume Lentil

Lentil seed were sown at a depth of 4 to 6 cm and a density of 200 seed m^{-2} in 4 m long rows, four rows per plot, with 25 cm between rows. Fertilizer at 22 kg p (50 kg P_2O_5) and 30 kg N ha^{-1} was added to the soil prior to sowing.

For data collection twenty lentil plants from each plot were picked out randomly and removed and then the plants height, pods number per plant, seed yield per plant, 100 seed weight, biomass yield and seed yield were noted. Harvest index calculated with Eq. 1:

$$HI = \frac{SY}{BY} \times 100 \quad (1)$$

Where:
HI : Harvest Index
SY : Seed Yield
BY : Biomass Yield

Coefficient of variance of the mentioned characters was calculated as Eq. 2:

$$CV\% = \frac{c_p - c_d}{c_p} \times 100 \quad (2)$$

Where:
Cv : Properties variation percent
C_p : Mean treats in non-stressed condition
C_d : Mean treats in drought stressed condition

Stress intensity was calculated according to Fisher and Maurer (1978) (Eq. 3)

$$SI = 1 - \frac{Y\bar{S}}{Y\bar{P}} \quad (3)$$

Where:
$Y\bar{P}$ = Mean of yield under normal condition
$Y\bar{S}$ = Mean of yield under drought stressed condition

Statistical procedures: SAS program used for analysis of variance and SPSS program for correlation parameter.

Table 2: Monthly rainfall, minimum and maximum air temperature at 2004-2005 seasons

	Air (°C)		
Months	Maximum	Minimum	Rainfall (mm)
April	15.0	2.3	45.8
May	20.3	6.4	51.6
June	26.7	10.5	16.5
July	31.3	14.5	5.4
August	32.1	14.9	4.5

RESULTS AND DISCUSSION

There were significant differences among genotype for all characters. Also, there were significant differences among stress for all characters except for harvest index. Other studies have also indicated the existence of variation for drought response among the genotypes under study (Salehi, 2005). There were also significant differences amongst the genotype×stress interaction for all characters except for seed yield, 100 seed weight (Table 3). Also, stress intensity (SI) was estimated 0.235 as Fisher and Maurer (1978).

Mean values and variation of traits: The mean value of seed yield in drought stress environment and normal condition was 20.2725 and 26.5161 g, respectively. CV% of seed yield was 23.5466% (Table 4). Silim *et al*. (1993b) and Grzesiak *et al*. (1996) reported seed yield reduced under drought stress. In Table 4, the seed yield per plant was most sensitive to drought stress but 100 seed weight was more tolerant trait as CV percent. Also Table 4, showed that maximum and minimum coefficient of variance percentage was in seed yield per plant and 100 weight seed, respectively. The coefficient variance percentage of harvest index obtained (%CV = -13.7425).

Results showed that seed yield per plant and number pod per plant was reduced by water deficient (Table 4). Thus the decrease in seed yield was mainly attributed to reduced seed yield per plant and pod number. This result agrees with Richards (1983) and Siddique *et al*. (1990). Total drought stress decreased all traits except harvest index.

Improvement in adaptation of lentil to drought stress environments requires improved tolerance to water deficient during flowering and poding.

Correlation between seed yield and other traits in normal condition: Harvest index was highly correlated with seed yield (r = 0.739 p<0.01) which is agree with Dutta and Mondal (1998). This character could be a good index for selecting high yield genotypes in normal condition. However, among number pod per plant and seed yield per plant have strongly correlation (r = 0.777 p<0.01). The correlation coefficient of seed yield per plant and number pod per plant with seed yield was significant and positive (Table 5). Esmail *et al*. (1994) showed that characters such

Table 3: Mean squares of yield and seed yield components of lentil under drought and normal condition

		MS						
SOV	df	Plant height	No. pod per plant	Seed yield per plant	100 weight seed	Biomass yield	Seed yield	Harvest index
Rep	2	1.011	70.496	369.889	0.143	1757.609	71.440	4.043
Stress	1	1721.798**	24275.245**	29997.894**	2.1583**	40549.296*	1169.314*	330.340
Error a	2	0.519	138.611	187.646	0.002	707.479	22.291	48.752
Genotype	19	8.857**	620.536**	923.182**	2.032**	705.182**	80.942**	99.772**
Genotype × stress	19	6.761**	247.845**	351.746**	0.182	591.745**	10.511	37.492*
Error b	76	0.816	122.929	146.594	0.185	195.676	9.095	22.961
CV%	-	3.670	17.750	19.120	8.920	14.870	12.890	18.470

* and **: Significant at the 5% and 1% levels of probability, respectively

Table 4: Mean values and variation of traits in lentil under normal and drought stresses conditions

Traits	Coefficient of variance (%CV)	Traits mean in normal condition	Traits mean in drought stressed condition
Plant height (cm)	26.3755	28.4183	20.9228
Number pod per plant	37.3406	77.0150	48.2568
Seed yield per plant (g)	39.9627	79.1461	47.5171
100 weight seed (g)	6.3685	4.6109	4.3173
Biomass yield (g m^{-2})	32.6836	112.4357	75.6876
Seed yield (g m^{-2})	23.5466	26.5161	20.2725
Harvest index (%)	13.7425	24.2713	27.6067

Table 5: Correlation between traits of lentil cultivars in normal condition

Traits	Plant height	No. pod per plant	Seed yield per plant	100 seed weight	Biomass yield	Seed yield	Harvest index
Plant height	1						
Number pod per plant	-0.187	1					
Seed yield per plant	-0.145	0.777**	1				
100 weight seed	-0.007	-0.174	-0.139	1			
Biomass yield	0.324	-0.010	-0.027	0.367	1		
Seed yield	-0.430	0.302*	0.327*	0.151	-0.076	1	
Harvest index	-0.494*	-0.029	-0.002	-0.113	-0.708**	0.739**	1

* and **: Significant at the 5% and 1% levels of probability, respectively

Table 6: Correlation between traits of lentil cultivars under drought stress condition

Traits	Plant height	No. pod per plant	Seed yield per plant	100 weight seed	Biomass yield	Seed yield	Harvest index
Plant height	1						
Number pod per plant	0.032	1					
Seed yield per plant	-0.024	0.721**	1				
100 weight seed	-0.373*	-0.033	-0.282	1			
Biomass yield	-0.209	0.345*	0.018	0.198	1		
Seed yield	0.029	0.353*	0.351*	-0.120	0.524*	1	
Harvest index	0.223	-0.006	0.317*	-0.344*	-0.494*	0.472*	1

* and **: Significant at the 5% and 1% levels of probability, respectively

as number pod per plant and seed yield per plant were efficient to be used in selecting genotypes with high yield capacity. Harvest index showed a highly significant negative correlation with biomass yield and plant height (r = -0.708; r = -0.444; respectively $p<0.01$ and $p<0.05$). The negative association between harvest index and biomass yield is illustrated by plant height which had non significant negative correlation with seed yield and produced low seed yield. Thus, as shown here and in other studies (Eissa *et al*., 1986; Singh *et al*., 1994). In conclusion, based on present study studies it seemed that harvest index, number pod per plant and seed yield per plant were useful characters to select for high yield for normal condition in plant breeding programs.

Correlation between seed yield and other traits in drought stress condition: The coefficients of correlation between grain yield and other traits studied in drought stress condition are shown in Table 6. Grain yield was significantly correlated with biomass yield (r = 0.524; $p<0.05$). This is expected to occur where more assimilates available to seed development ate associated with more vegetative growth. This result agreed with those of Migdadi and Duwayri (1994). Grain yield was correlated significantly and positively with number pod per plant, seed yield per plant and harvest index (r = 0.353, 0.351 and 0.472, respectively; $p<0.05$ in all cases). This result agreed with those of Luthra and Sharma (1990). Also, a positive but insignificant correlation was found between grain yield and plant height (r = 0.029). The correlation amongst number pod per plant and seed yield per plant were strongly significant and positive (r = 0.721; $p<0.01$) which is agree with Manora and Manara (1988). We suggest that the traits of pod number per plant, seed yield per plant, biomass yield and harvest index are important characters under drought stress conditions, as found by other researcher (Rajput and Sarwear, 1989).

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