INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
VOLUME-2, ISSUE-2 APRIL-JUNE-2012 ISSN 2231-4490

Coden : IJPAES www.ijpaes.com

Received: 07th Mar-2012 *Revised: 16th Mar-2012* *Accepted: 20th Mar-2012*
Research Article

SEED QUALITY OF LENTIL (*LENS CULINARIS* MEDIK.) AFFECTED BY SALINITY STRESS

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ABSTRACT : A factorial experiment on the basis of RCB design with three replications was conducted in 2011 to evaluate the effects of salt stress (control, 4, 8, and 12 dS/m NaCl, respectively) on seed quality of lentil. Seeds were harvested at ten day intervals in three stages (55, 65 and 75 days after flowering, respectively). Changes in seed weight and electrical conductivity of seed leachates were recorded for seeds harvested at these stages. Germination percentage, germination rate and seedling dry weight were also determined for seeds of final harvest (75 days after flowering). Electrical conductivity of seed leachates decreased with progressing seed development and enhancing seed weight on the mother plant under both saline and non-saline conditions. Electrical conductivity of lentil seed leachates increased, butgermination percentage, germination rate and seedling dry weight decreased with enhancing salinity levels. Reduction in these traits was related with ion imbalances and membrane disruption under salt stress. It is, therefore, preferable to produce lentil seeds under non-saline conditions.
Keywords: Electrical conductivity, Lentil, Salinity stress, Seed quality

INTRODUCTION

The quality of seed used by farmer determines the status of agriculture they practice. In the field, seed quality means the ability to germinate, to emerge and to produce healthy seedlings rapidly, uniformly, under a wide range of environmental conditions, and to maintain this ability for a long period [1]. Seed quality could be influenced by genetic constitution, environment and nutrition of mother plant, stage of maturity at harvest, seed size, seed deterioration, mechanical damage and pathogens [2]. Low quality seeds can potentially decrease the rate and percentage of germination and seedling emergence, leading to poor stand establishment in the field and consequently yield loss in many crops such as corn [3,4], cotton [5], barley [6,7] and oilseed rape[8].

Stage of maturity at harvest is one of the most important factors that can influence the quality of seeds [9]. Harvesting too early may result in low yield and quality, because of the partial development of essential structures of seeds [10, 11, 12]. According to some researchers [13, 4] mass maturity (end of seed filling phase) previously described as physiological maturity is a good sign of achieving maximum seed quality on the mother plant. In contrast, many reports on various crops suggest that maximum seed quality is attained after mass maturity [14, 15, 16, 17]. It was reported that water stress can reduce crop yield, but it has no significant effect on seed quality [18, 19, 15, 16, 20].

Among the abiotic stresses, salinity is a major threat to sustainable crop production in many parts of the world [21, 22, 23, 24, 25, 26, 27]. Salinity can reduce plant growth by disturbing biomass allocation, ion relations, water relations, and other physiological processes or by a combination of such factors [21]. According to [28] seed viability and germination rate of chickpea cultivars are increased with enhancing seed weight on the mother plant under both saline and non-saline conditions. However, seed weight and consequently viability percentage and germination rate decreased as salinity increased. Means of maximum seed viability and rate of germination for seeds produced under control and moderate salinity were not significantly differed, but these traits for seeds produced under high salinity were significantly lower than those for control. Thus, this research was conducted to investigate the changes in seed quality of lentil at different stages of seed development and maturity under saline and non-saline conditions.

MATERIALS AND METHODS

A Factorial experiment based on randomized complete block design with three replications was carried out in 2011 at the Greenhouse of the University of Tabriz to evaluate changes in seed quality of microsperma lentil (cv.Kimia) harvested at three stages under a non-saline (control) and three saline (4, 8 and 12 dSm^{-1}NaCl) conditions.Lentil seeds were obtained from Agricultural Research Institute, Kermanshah, Iran. Twenty seeds after treating with 2 g/kg benomyl were sown 2 cm deep in each pot filled with 900 g perlite, using 48 pots in general. The temperature in the greenhouse varied between 20 and 34ºC. Tap water (EC=0.6dS/m) and saline solutions were added to the pots in accordance with the treatments to achieve 100% FC.

After emergence, seedlings were thinned to keep six plants in each pot. During the growth period, the pots were-weighed and the losses were made up with Hoagland solution (EC= 1.3dS/m). Perlites within the pots were washed every 30days and non-saline and salinity treatments were reapplied in order to prevent further increasein electrical conductivity (EC) due to adding Hoagland solution. During grain filling, seeds were harvested at 10 days intervals, beginning 55 days after flowering. Seed quality tests were carried out at the Seed Technology Laboratory of Tabriz University. Changes in seed weight and electrical conductivity of seed leachates were recorded for seedsharvested at three stages (H_1, H_2 and H_3:55, 65 and 75day afterflowering, respectively). Germination percentage, germination rate and seedling dry weight were also determinedfor seeds of final harvest (75 days after flowering).

For electrical conductivity test, seeds of each treatment immersed in 100 ml deionized water in a container at 20°C for 24 hours. The seed-steep water was then gently decanted and electrical conductivity (EC) was measured, using an EC meter. Samples were tested for germination, using filter papers. Ten seeds from each pot were placed between two 30×30 cm wetted and rolled filter papers, which were then placed in plastic bags to prevent water loss. These bags were incubated at 10°C for 11 days. Number of germinated seeds (protrusion of radicle by 2 mm) was recorded every day and germination rate was calculated according to [29]. At the end of the test, normal and abnormal seedlings were countedand percentagegermination was calculated.Then seedlings were cut and dried in an oven at 80°C for 24 hours and mean seedling dry weight for each sample was determined. Analysis of variance and comparison of means at $p \leq 0.05$ were performed, using SPSS and SAS softwares. Excel software was used to draw figures.

RESULTS AND DISCUSSION

Mean seed weight of lentil linearly increased during grain filling from 55 to 75 days after flowering. However, seed weight decreased as salinity increased. The extent of this reduction under 8 and 12 dS/m was more evident than that under 4 dS/m NaCl salinity (figure 1). Decreasing seed weight of lentil under salinity may be attributed to the reduction of carbon metabolism [30] and photosynthesis [31]. These results are in agreement with those reported for wheat [32, 33, 34], bean [35], soybean [36], oilseed rape [37], and chickpea [38, 28].

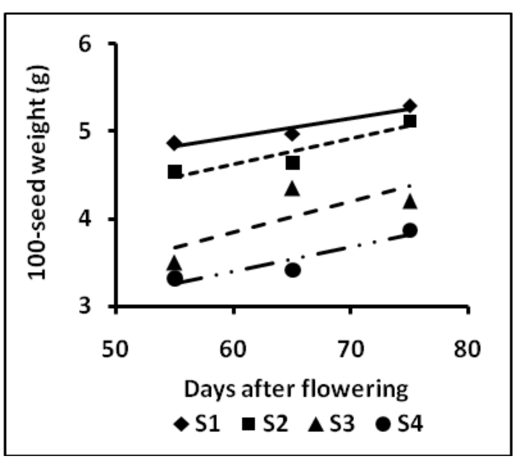

Fig. 1. Changes in seed weight of lentil at different stages of development under non-salineand saline conditions (S_1, S_2, S_3 and S_4 : control, 4, 8 and 12 dS/m NaCl salinity, respectively).

Electrical conductivity of seed leachates linearly decreased, with progressing seed development and enhancing seed weight under different salinity treatments. Increasing NaCl salinity continuously increased electrical conductivity of lentil seed leachates (figure 2). High electrical conductivity of lentil at earlier stages of seed development was due to immaturity, similar to that reported for soybean [39, 40, 41, 42], commn bean [15], fababean [16] and maize [4].

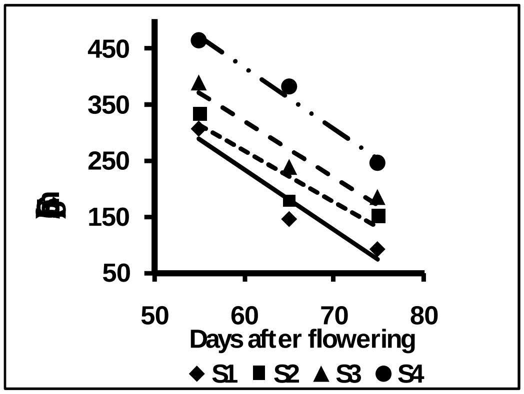

Fig. 2. Changes in electrical conductivity of lentil at different stages of development under non-saline and saline conditions (S_1, S_2 ,S_3 and S_4:control, 4, 8 and 12 dS/m NaCl salinity, respectively).

Analysis of variance of the data for seeds of final harvest showed that all quality parameters were significantly affected by salinity stress (Table 1).Mean seed weight, germination percentage, germination rate and seedling dry weight significantly decreased, butelectrical conductivity of seed leachates increased with increasing NaCl salinity. Reduction in seed quality under moderate and severe salinities was comparatively high (Table 2).Reductions in germination percentage, germination rate and seedling dry weight for seeds produced under saline conditions may be related with ion imbalances (Na^+ and Cl^-) and membrane disruption [28].

Table 1.Analysis of variance of maximum seed weight and seed quality parameters of lentil produced Under non-saline and saline conditions.

Source of variance	Degrees of freedom	100-Seed weight	Electrical conductivity	Germination percentage	Germination rate	Seedling dry weight
Blocks	2	0.1691^{ns}	4878.74^{ns}	175^{ns}	50.27^{ns}	0.00032^{ns}
Salinity	3	1.52^{**}	12674.5^{**}	497.22^{**}	140.36^{**}	0.0014^{*}
Error	6	0.1467	1238.83	63.88	25.52	0.00014
CV (%)	-	8.83	20.95	11.84	24.9	13.67

^{*,**,ns} Significant at p≤0.05 , P≤0.01 and not significant, respectively.

Table 2. Comparison of means of maximum seed weight and seed quality parameters of lentil produced under non-saline and saline conditions

Treatment	100-Seed weight (g)	Electrical conductivity (µS/cm/g)	Germination percentage (%)	Germination rate (per day)	Seedling dry weight (g)
Salinity (dS/m)					
control	5.29a	89.93a	76.66a	29.28a	0.117a
S_1	5.01ab	151.21ab	73.33a	22.78a	0.0999ab
S_2	4.20b	185.3b	64.33ab	20.89ab	0.0815ab
S_3	3.87b	245.45b	53.33b	19.8b	0.0679b

Different letters in each column for each treatment indicate significant difference at P≤0.05.

CONCLUSIONS

Seed quality of lentil enhances with progressing seed development and weight on the mother plant both under non-saline and saline conditions. However, salt stress can reduce seed quality at different stages of pod filling. Therefore, it is preferable to produce lentil seeds under non-saline conditions.

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