academicJournals

Vol. 8(5), pp. 225-231, May 2014
DOI: 10.5897/AJPS2014.1176
Article Number: CA7D29544930
ISSN 1996-0824

http://www.academicjournals.org/AJPS

African Journal of Plant Science

Full Length Research Paper

The effect of salinity (NaCl) on germination and early seedling growth of *Lathyrus sativus* and *Pisum sativum* var. *abyssinicum*

Berhanu Abraha Tsegay[1]* and Berhane Gebreslassie[2]

[1]Department of Biology, Bahir Dar University, Ethiopia.
[2]Department of Biology, Woldia University, Ethiopia.

Received 11 March, 2014; Accepted 17 April, 2014

High salt level of a germination medium may induce a reduction, delay and even complete inhibition of germination due to osmotic effect and/or ion toxicity. The objective of this study was to investigate the effect of salinity due to NaCl on germination and early seedling growth of two crops, *Pisum sativum* var. *abyssinicum* and *Lathyrus sativus.* Seeds of these two crops were treated with NaCl induced saline germinating media prepared in Petri dishes. Fifty (50) surface sterilized seeds per Petri dish were sown in five salt treatments (0, 5, 7, 9 and 15 dSm^{-}). Each treatment was replicated four times. Germination percentage, shoot length and root length of both crops decreased with an increase in salinity level. Although both crops are low salt tolerant legumes, *P. sativum* var. *abyssinium* was found to be less tolerant than *L. sativus.* This study could be strengthened by further work under field conditions and also at mature vegetative and reproductive stages of the crops.

Key words: Germination time, water uptake percentage, salt tolerance, seedling biomass.

INTRODUCTION

Germination is the initial stage of a plant's life cycle and determines where and when a crop can be established. It is a complex metabolic process that oxidizes the lipids and carbohydrates within the seed and breaks down storage proteins in order to obtain energy and amino acids necessary for plant development (Almansouri et al., 2001). Seed germination and early seedling growth under saline conditions are considered as major factors limiting the establishment of crops (Kitajima and Fenner, 2000). Interaction between seedbed environment and seed quality is also important (Khajeh-Hosseini et al., 2003). Plant available water is restricted in soils containing excess sodium chloride, resulting in partial dehydration of cell cytoplasm. Such plasmolysis affects the metabolism of cells and functions of macromolecules and, ultimately, results in cessation of growth (Le Rudulier, 2005).

The effect of salinity on germination can be either by creating osmotic potential which prevents the uptake of

*Corresponding author. E-mail: berhanu.tsegay@yahoo.com.

water or by the toxic effects of ions on embryo viability (Houle et al., 2001). Salts absorb and retain water with such strength that it is not freely available in the soil, causing an increase of soil solution osmotic pressure. Salt stress may cause significant reductions in the rate and final germination percentage (FG %), which in turn may lead to an uneven stand establishment and a reduction in yields.

Rapid, uniform and a high germination percentage for legumes is a prerequisite for successful stand establishment and yield (Demir and Ermis, 2003). The specific ions likely to be most abundant and cause greatest problems are sodium (Na^+) and chloride (Cl^-).

The legume family is the third largest of flowering plants (Morris et al., 2003; Lewis et al., 2005). Economically, legumes represent the second most important family of crop plants after Poaceae (grass family), accounting for approximately 27% of the world's crop production (Graham and Vance, 2003). Legumes, in developing countries, are largely produced as subsistence crops by small hold farmers. Ethiopia is a good producer of food legumes after Egypt in Africa (Lewis et al, 2005). However, about 10,608 ha of Ethiopia's total land is affected by salinity in semi-arid and arid regions (Geressu, 2011), which may reduce yield. Moreover, irrigated lands in the semi-arid parts of the country are increasingly becoming saline and turning to a new scenario of hampering food production for the fast growing population.

Reclaiming salt affected land is always costly and time consuming (Turan et al., 2007). Therefore, in countries like Ethiopia where legumes are principally grown for human consumption; the focus should remain on the development of salt tolerant cultivars to attain food security of the rapidly growing population. For this purpose, screening of suitable crops and cultivars is necessary. Identification of salt tolerant crops and cultivars is important so that such unproductive land can be used. Although, to our knowledge, there is no previous data available on *L. sativus* and *P. sativum* var. *abyssinicum* response to salinity in Northern Ethiopia. The objective of this study was therefore to investigate the effect of salinity on germination and early seedling growth of *P. sativum* var. *abyssinicum* and *L. sativus*.

MATERIALS AND METHODS

This study was conducted from October 2012 - March 2013 in the Laboratory of Botanical Sciences at the Department of Biology, Bahir Dar University, Ethiopia. Sterilized, hand selected seeds of both *L. sativus* (from Adet, Amhara Region) and *P. sativum* var *abyssinicum* (from Maichew, Tigray Region) were used for the study. Before beginning the experiment, solutions were made by dissolving sodium chloride in distilled water at five different concentrations (0, 5, 7, 9 and 15 dSm^- EC) (Li, 2008) and left for 48 h in order to dissolve. The salt solutions were prepared every six days so that it is relatively fresh for the germinating seeds.

Following the solution preparation, Petri dishes were washed and disinfected with alcohol and air dried. Germination chambers were prepared from the sterilized glass Petri dishes and filter papers (Whatman No. 2). The filter papers were cut into two pieces of equal size with labeled seed compartments and concentrations of salt solutions; and made ready for use. Treatments were arranged in a completely randomized design (CRD) and each treatment combination was replicated four times.

Dry weight of the hand selected seeds were recorded before the seeds were surface sterilized with 5% sodium hypochlorite solution for 10 min and rinsed with sterile distilled water three times. Fifty seeds were sown in each Whatman filter paper bedded dishes (Kaya et al., 2005). The seeds were watered with the appropriate salt solutions and left for 24 h where after, the fresh weight was recorded to calculate the uptake of water by the seeds. This was done as follows (Gairola et al., 2011):

Water uptake percentage =

$$\frac{\text{Seed fresh weight} - \text{Seed dry weight}}{\text{Seed fresh weight}} \times 100$$

After the measurement of water uptake, the seeds were re-sown into the Petri dishes. They were then watered daily with the appropriate salt solutions. All the germination and early seedling growth parameters were evaluated using the method used by Li (2008) with some modifications. Counting germinated seeds started 24 h after sowing every day for 14 days. A seed was considered to be germinated when plumule and radical emerge from the seeds. In all treatments, a continuous assessment in seedling growth were carried out during the subsequent days for both study crops, until day 14.

Germination rate (GR), which is important for state of readiness for early seedling growth under laboratory condition was evaluated as follows:

Germination rate = $(X_n – (X_n\text{-}1))/Y_n$

where, X_n is the number of germinated seeds at the n^{th} day and y_n is the number of days from sowing until the n^{th} harvesting time.

Germination Percentage (GP %): (GP) =

$$\frac{\text{Number of germinated seeds}}{\text{Total number of seeds sown}} \times 100$$ (Kandil et al., 2012).

Mean germination time (MGT): MGT = $\frac{\sum dn}{\sum n}$ (Kandil et al., 2012)

Where n is the number of seeds which germinated on day 'd', and 'd' is the number of days counted from the beginning of germination.

Germination index (GI): was calculated as the product of number of days after sowing and number of germinated seeds divided by the total number of sown seeds.

GI = $\frac{\sum diNi}{S}$ (Li, 2008)

where 'di' is number of days after sowing of seeds under a particular treatment, 'Ni' is number of germinated seeds, 'S' is total number of sown seeds of the study legume crops.

Seedling height reduction (SHR): the delay in root length and shoot length expressed in percentage was calculated as:

$$\frac{\text{Plant height at control} - \text{plant height at salt treat condition}}{\text{Plant height at control}} \times 100$$

(Morris et al., 2003)

Relative NaCl injury rate was calculated as the difference between germination percentage in control and germination percentage in salt treated seeds dividing by the germination percentage in the untreated seeds. The emergence of radicle (root) and shoot (plumule) of *P. sativum* and *L. sativus* from each Petri dish were assessed every day after sowing. And then the salt tolerance rate was calculated by using the standard formula used by Kaymakanova (2009):

$$\text{Salt tolerance (ST)} = \frac{\text{Seedling dry weight of treated}}{\text{Seedling dry weight in control}} \times 100$$

Data analysis

All collected data for germination and early seedling growth were organized, analyzed and interpreted using SPSS 20 for Windows and Microsoft excel softwares. Variance were statistically computed by analysis of variance (ANOVA) for the complete random design using SPSS version 20, and comparisons of means were made using the Tukey HSD significant difference test (HSD) at $P<0.05$. Graphics and tables were used to show the distribution of the response of the seeds to the different treatments.

RESULTS AND DISCUSSION

Water uptake percentage

Entry of water into seeds is greatly influenced by the nature of the seed coat (pericarp). Seeds of *L. sativus* and *P. sativum* var. *abyssinicum* respond differently though they are treated with the same salt concentrations. The results in Table 1 indicate that water uptake percentage increased in seeds of *L. sativus* and *P. sativum* treated with higher salt concentrations as compared to those treated with distilled water. In both seeds, the ability to absorb water is influenced by the concentration of salts and index of reduction increases with increasing salinity level from 9 to 15 dSm^-.

Seeds of *P. sativum* showed a high percentage of water uptake increment in all NaCl solution treatments except at the 7 dSm^- as compared to that of *L. sativus* seeds (Table 1). The overall water uptake percentage was not, however, statistically significant ($p < 0.05$) between the crop types and among the different salt concentrations except at 5 dSm^- for *L. sativus* (Table 1). This is as a result of large sample size.

Germination percentage

The interaction between the crops and salt concentrations was significant, meaning that the crops respond differently at specific salt concentration. This is shown by the significant differences ($P < 0.001$) in germination percentage of the two crop types given in all treatments (Table 1). Increased salt concentration caused decrease in germination percentage, but the extent of reduction under high concentration stress was much greater than that under low salt stress (Table 1).

Under the highest salt concentration (15 dSm^-), no seed germinated for either crop. Germination percentage of *L. sativus* was significantly ($p < 0.05$) higher than *P. sativum* var. *abyssinicum* at all salt concentrations (Table 1). This suggests that seeds of *L. sativus* could germinate well at a relatively higher concentration of NaCl than *P. sativum* var. *abyssinicum* seeds.

Germination rate

Differences among NaCl treatment were statistically significant ($P<0.0001$) for germination rate of the study seeds. The germination rate decreased as salt concentration increased to a 9 dSm^- and delayed for the highest salt dosage (Table 1). Since the higher salt concentration limited the water absorption, it slows down the germination rate. Higher germination rate was recorded for *L. sativus* seeds at 0, 5, and 7 dSm^- salt concentrations as compared to *P. sativum* var. *abyssinicum.* No seeds germinated at the highest salt concentration (15 dSm^-) for both species. Since higher salinity limited water absorption, it prevents nutrient assimilation, as a result, germination rate declined with increasing salinity. The results of this study were similar to the findings of Akhtar and Hussain (2008) and Kaydan and Yagmur (2008) who worked on different plant species. For example, Akthar and Hussain (2008) reported that germination of three grasses (*Bothriochlo apertusa, Dichanthium annulatum* and *Panicum antidotale*) significantly declined even at 5 dSm^- level of treatment.

Mean germination time

Salinity had a considerable increasing effect on germination time of *P. sativum* var. *abyssinicum* and *L. sativus* up to a certain level (Table 1). The increasing effect was more for *L. sativus* as compared to *P. sativum* var. *abyssinicum.* The highest average mean germination time was obtained from seeds treated with the 5 dSm^- salt concentration. In this study, mean germination time for *P. sativum* var. *abyssinicum* seeds at 5 dSm^- was higher than the control. This difference is significant at $p< 0.05$. There was also a significant difference ($P < 0.001$) in mean germination time of the two crops at 0, 5 and 7 dSm- salt concentrations. It means that the higher the salt concentration the longer the germination time until seeds develops tolerance and starts to germinate by overcoming the germination time delay (Patto, 2009).

L. sativus seeds took much time for germination than *P. sativum* var. *abyssinicum* seeds though both of them increased in mean germination time with increased salt solution treatment up to 5 dSm^-. That means seeds of *L. sativus* can tolerate salinity effect up to 9 dSm^- than *P. sativum* var. *abyssinicum* seeds. This shows that *L. sativus*

Table 1. Means comparison for effects of salinity (NaCl) on water uptake, percent germination, germination index, germination rate and mean germination time of *L. sativus* and *P. sativum* var. *abyssinicum.*

NaCl (dSm^-)	Water uptake (%)		Germination (%)		Germination index		Germination rate		Mean germination time (day)	
	L. sativus	***P. sativum***	***L. sativus***	***P. sativum***	***L. sativus***	***P. sativum***	***L. sativus***	***P. sativum***	***L. sativus***	***P. sativum***
0	84.83^{ab}	55.34^{ab}	99.9^{a}	84.40^{bc}	4.31^{a}	3.92^{ab}	13.22^{a}	12.86^{a}	2.91^{ab}	1.98^{c}
5	91.95^{ab}	73.89^{ab}	81.90^{b}	38.55^{d}	5.45^{a}	2.73^{bc}	10.34^{b}	5.44^{c}	3.63^{a}	2.26^{bc}
7	87.72^{ab}	71.90^{ab}	65.95^{c}	18.85^{ef}	5.24^{a}	1.11^{d}	8.66^{b}	2.82^{de}	3.50^{a}	0.74^{d}
9	86.45^{ab}	81.30^{ab}	22.10^{e}	5.90^{gf}	1.37^{cd}	0.58^{d}	3.53^{cd}	0.92^{ef}	0.91^{d}	0.38^{d}
15	89.11^{ab}	84.70^{ab}	0.00^{g}	0.00^{g}	0.00^{d}	0.00^{d}	0.00^{f}	0.00^{f}	0.00^{d}	0.00^{d}

Superscripts within the means of each column (a-f) with different letters indicate significant difference among means ($p<0.05$, using Tukey HSD test).

seeds are capable of germinating if the adverse effect of salinity is not extreme during their dormancy period. Delayed germination causes increased irrigation cost and irregular and weak seedling growth in the establishment of legume crops. Relevant results were reported by Gunjaca and Sarcevic (2000) and Almansouri et al. (2001). They reported that increasing osmotic potential decrease water uptake and slow down germination time.

Germination index

The germination index of both crops decreased significantly with increasing NaCl concentration (Table 1). The reduction gets stronger particularly at the higher level of salt concentration when compared with the control. Thus, germination index and NaCl concentration were negatively correlated. *L. sativus* was less affected by salt treatments as it has long, hard and penetrating root system than *P. sativum* var. *abyssinicum*. On the other hand, *P. sativum* var. *abyssinicum* seeds were more sensitive to the same salinity levels. In this crop, increase in salt concentration caused higher decreases in germination index values as compared to *L. sativus* (Table 1).

Generally, increase in salt concentration decreased the germination index of the study crops and this is in line with the findings of Khayatnez and Gholamin (2011) in *Zea mays* that showed decreased germination index as salt concentration increased. Previous reports from other workers also corroborate these results, for instance, Khan et al. (2009) reported on hot pepper. In this study, germination index of *P. sativum* var. *abyssinicum* decreased significantly with increasing NaCl concentration (Table 1). The reduction gets stronger particularly at 9 dSm^- NaCl concentration as compared to the control. Total decline in germination was observed at the highest salinity level (15 dSm^- NaCl). An increased germination index is indicative of decreased phytotoxicity and thus of a more mature germinated seeds (Khayatnezhad and Gholamin, 2011). However, results obtained using the germination index should be interpreted with care because they are affected by the type of seed used and the source of salinity. Application of damaged seeds and non-stabilized salts ($CaCl_2$) to germinating seeds may lead to immobilization of plant nutrients and cause phytotoxicity (Khan et al., 2009).

Effects of salinity on early seedling growth

Generally, germination and early seedling growth declined with increasing salinity levels, although reduction in root length was higher than reduction in shoot length. With higher salt concentration seedling growth rate declined in both crops. Root elongation was sensitive than shoot under the stresses on both seeds. It was affected at the lowest salt stresses (5 and 7 dSm^-) and was completely inhibited at the highest salt (15 dSm^-) concentrations (Table 2). As the osmotic pressure decrease at the germination environment, water cannot carry most of the water soluble nutrients to the root in order to increase osmotic pressure of roots to get enough water. Similar results were also found in older seedlings of chick pea by Li (2008). Thus, salinity had a deleterious effect and even total decline in seedling growth rate as the level of salinity increased beyond the tolerance range which could have resulted from a lower absorption of salt component by seed, and

Table 2. Mean comparisons for effects of salinity (NaCl) on root length, root height reduction, root fresh weight, root dry weight, shoot length and shoot height reduction of *L. sativus* and *P. sativum* var. *abyssinicum*.

NaCl (dS/m$^-$)	Root length (cm)		Root height reduction (%)		Root fresh weight (g)	
	L. sativus	*P. sativum*	*L. sativus*	*P. sativum*	*L. sativus*	*P. sativum*
0	10.26^{a}	8.03^{b}	0.00^{d}	0.00^{c}	7.4^{a}	6.7^{a}
5	4.13^{c}	2.01^{c}	57.37^{c}	74.34^{bc}	6.5^{a}	4.55^{b}
7	1.47^{cd}	0.55^{d}	57.37^{c}	92.84^{ab}	3.7^{bc}	4.55^{b}
9	1.47^{cd}	0.55^{d}	93.32^{ab}	92.84^{ab}	3.7^{bc}	1.83^{cd}
15	1.47^{cd}	0.00^{d}	93.32^{ab}	100^{a}	3.69^{bc}	1.83^{cd}
NaCl (dS/m$^-$)	**Root dry weight (g.)**		**Shoot length (cm)**		**Shoot height reduction (%)**	
	L. sativus	*P .sativum*	*L. sativus*	*P. sativum*	*L. sativus*	*P. sativum*
0	2.85^{ab}	3.48^{a}	10.12^{a}	10.29^{b}	0.00^{e}	0.00^{a}
5	2.51^{abc}	2.28^{bc}	8.93^{b}	7.79^{b}	12.70^{de}	24.06^{cde}
7	2.51^{abc}	1.82^{c}	5.31^{c}	6.15^{cd}	45.58^{bcd}	40.72^{bcd}
9	1.68^{cd}	0.98^{de}	3.80^{cd}	4.51^{de}	71.06^{ab}	54.58^{bc}
15	0.00^{e}	0.00^{e}	0.00^{e}	.0.00^{d}	79.82^{ab}	100^{e}

Superscripts (a-e) with different letters indicate significant difference among means within the columns ($p<0.05$, using Tukey HSD).

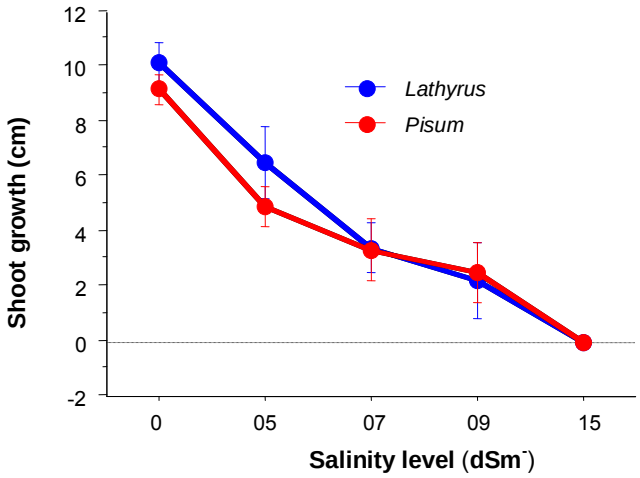

Figure 1. Seedling length of *L. sativus* and *P. sativum* var. *abyssinicum* grown under saline conditions at different stress levels. Error bars ± standard deviation.

germination process is also less responsive to high tissue sodium concentrations than seedlings growth (Figure 1).

The results of the present study showed that *P. sativum* var. *abyssinicum* and *L. sativus* roots during early seedling growth were more markedly inhibited than shoots under same salt stress conditions (Table 2). When compared with shoot, root elongation is more sensitive to the stress and is injured more severely (Table 2) because they are the first organs to face the stress. The injurious effect caused by salt stress was much greater on *P. sativum* var. *abyssinicum* than *L. sativus* (Table 2).

Sowing *P. sativum* var. *abyssinicum* under 7 dSm$^-$ salt stress had recorded lower root elongation than *L. sativus* seeds with significant difference between the two legumes ($p<0.01$). This species was highly affected as salinity stress level increases. However, both study crops at higher salinity levels, that is 9 dSm$^-$ produced the shortest roots with significant differences between them. In addition, results showed that maximum root length was obtained from sown *L. sativus* in the control treatment (Table 2).

Means comparison indicated that a significant reduction of leaf number was observed between seed types when salinity stress was increased from 0 to 9 dSm$^-$ while there

Table 3. Means comparison for effects of salinity (NaCl) on shoot dry weight, leaf number, relative NaCl injury rate, shoot fresh weight, seedling biomass and salt tolerance of *L. sativus* and *P. sativum* var. *abyssinicum*.

NaCl (dSm$^-$)	Shoot dry weight			Leaf number	Relative injury rate	
	L. sativus	*P. sativum*	*L. sativus*	*P. sativum*	*L. sativus*	*P. sativum*
0	3.42^{ab}	2.95^{bc}	1.93^{a}	1.68^{ab}	00^{f}	8^{ef}
5	4.12^{a}	3.52^{ab}	1.48^{b}	0.79^{cd}	18de	56^{c}
7	2.24^{cd}	1.73^{de}	0.99^{c}	0.79^{cd}	34^{d}	78^{b}
9	2.44^{cd}	1.40^{e}	0.37^{de}	0.33^{e}	78^{b}	93^{ab}
15	0.00^{f}	0.00^{f}	0.00^{e}	0.00^{e}	100^{a}	100^{a}

NaCl (dS/m$^-$)	Shoot fresh weight		Seedling biomass		Salt tolerance	
	L. sativus	*P. sativum*	*L. sativus*	*P. sativum*	*L. sativus*	*P. sativum*
0	7.40^{a}	5.03^{a}	1.00^{a}	0.79^{ab}	100^{a}	100^{a}
5	8.8^{a}	7.40^{b}	0.46^{bc}	0.28^{cd}	84.19^{a}	83.86^{a}
7	4.83^{b}	3.36^{bc}	0.27^{cd}	0.10^{d}	55.10^{b}	49.01^{b}
9	5.06^{b}	2.88^{c}	0.27^{cd}	0.21^{cd}	59.95^{b}	39.18^{b}
15	0.00^{f}	0.00^{f}	0.00^{d}	-0.00^{d}	-0.00^{c}	-0.00^{c}

Superscripts (a-f) with different letters indicated significant difference among means within columns ($p<0.05$, using Tukey HSD).

was no significant difference between salinity levels of 0, 5 and 7 dSm$^-$. Increasing salinity to 9 dSm$^-$ NaCl decreased shoot fresh weight, shoot dry weight, leaf number, seedling biomass, salt tolerance and increased relative sodium chloride injury of the two crops (Table 3). Shoot fresh weight was significantly influenced ($P<0.05$) by salinity levels. The highest shoot fresh weight was obtained from 5 dSm$^-$ salinity level while the lowest weight was at 15 dSm$^-$. Plant growth was affected positively up to 5 dSm$^-$ salt levels. At this level shoot fresh weight was higher than the control. However, shoot fresh weight significantly decreased as salinity level increased above 5 dSm$^-$ (Table 3). This result was supported by the findings of Kaya et al. (2005) who showed that shoot fresh weight increased in low NaCl levels for some plants.

Salinity stress significantly ($P<0.05$) affected shoot dry weight as the salt concentration dosage increased. Shoot dry weight significantly decreased at salt levels over 7 dSm$^-$. The highest shoot dry weights obtained (4.12 and 3.52 g for *L. sativus* and *P. sativum* var. *abyssinicum,* respectively) were from 5 dSm$^-$ salinity level, which were statistically different from the control. The present findings are in agreement with the results of other researchers on Alfalfa and Ryegrass (Mohammadi et al., 2008; Pessarakli and Kopec, 2009).

Leaf number and seedling biomass

Means comparison indicated that a significant reduction of leaf number and seedling biomass was observed between seed types when salinity stress was increased from 0 to 9 dSm$^-$. At the higher salt concentration (9 dSm) the leaf number was extremely affected and made seedlings less thrived for the stress. Leaves were totally delayed at the highest concentration (15 dSm$^-$) for both crops (Table 3). Seedling biomass of the crops also reduced as salt concentration increased (Table 3). Rahman et al. (2008) reported such a reduction and the reasons were believed to be due to slow or less mobilization of reserve foods, suspending the cell division, enlarging and injuring hypocotyls with increase in salt concentration in Gina cultivar. When the two species were compared, seedling biomass was higher for *L. sativus* than *P. sativum* var. *abyssinicum*.

Relative sodium chloride (NaCl) injury rate

The injury rate at 15 dSm$^-$ was 100% for both species. Effects were significant at all salt concentrations except at 5 and 7 dSm$^-$ for *L. sativus* and at 7 and 9 dSm$^-$ for *P. sativum* var. *abyssinicum* (Table 3). Relative NaCl injury rate was found to be higher for *P. sativum* var. *abyssinicum* as compared to *L. sativus* seeds at the same salt treatments. There was a direct relationship between the salinity levels and injury rate on both crops. Injury rate increased with increasing concentration of salinity level. This was similar to earlier studies made by Hadush and Gebreslassie (2012) on *L. sativus* landraces.

Salt tolerance

The present study indicates that salt tolerance in early

seedling stage was not correlated with seed germination. There were germinated seeds at the highest concentration (15 dSm^{-}) but died upto three days after germination (Table 3). This shows germination stage is more saline tolerant, which could result from a lower absorption of salt components by the seed. Germination process is also less responsive to high tissue sodium concentrations than seedlings growth. The result agrees with that of Mahdavi and SANAVY (2007) for *Schinopsis quebracho* where seeds at germination stage were relatively tolerant to salinity that at a later seedling stage. There was no tolerance at highest salinity (15 dSm^{-}) in both species. The difference in response to salinity shown by the two species at early stage of development may be related to their morphological and physiological variation. Results by Munns and James (2000) showed that crop plants could be salt tolerant at germination but turned salt sensitive during vegetative development.

Conclusion

Salt (NaCl) stress through enhancement of osmotic pressure leads to the reduction of germination percentage, germination rate, germination index and increase in mean germination time of *P. sativum* var. *abyssinicum* and *L. sativus* seeds. Salinity disturbed the metabolic and physiological processes starting from the imbibitions stage. *L. sativus* seeds were different from *P. sativum* var. *abyssinicum* for all the studied germination and seedling growth traits. Germination percentage decreased significantly with increasing salt concentration (≥ 7 dSm^{-}). Dry and fresh weight of seedlings decreased as seedling length declined with increasing salinity levels because root number, shoot number, root length and shoot length decreased significantly. The injurious effect caused by salinity stress was much greater on *P. sativum* var. *abyssinicum* than *L. sativus*. Roots of the early seedlings of *P. sativum* var. *abyssinicum* and *L. sativus* were more markedly inhibited than shoots under salt stress conditions. Salt tolerance in early seedling stage was not correlated with later developments. The results indicated the availability of salinity tolerant crops (to medium salinity) that could be useful in future planning for saline environments.

REFERENCES

Akhtar P, Hussain F (2008). Salinity tolerance of three range grasses at germination and early growth stages. Pak. J. Bot. 40:2437-2441.

Almansouri MJ, Kinet M, Lutts S (2001). Effect of salt and osmotic stress on germination in durum Wheat (*Triticum durum* Desf.). Plant Soil 231:243-254.

Demir I, Ermis S (2003). Effect of controlled hydration treatment on germination and seedling growth under salt stress during development in tomato seeds. Euro. J. Hortic. Sci. 68:53-58.

Gairola KC, Nautiyal AR, Dwivedi AK (2011). Effect of temperatures and germination media on seed germination of *Jatropha Curcas* L. Adv. Biores. 2:66-71.

Geressu K (2011). The Response of Some Haricot Bean (*Phaseolus vulgaris*) Varieties for Salt Stress during Germination and Seedling Stage. Curr. Res. J. Biol. Sci. 3:282-288.

Graham PH, Vance CP (2003). Legumes: Importance and constraints to greater use. Plant Physiol. 131:872-877.

Gunjaca J, Sarcevic H (2000). Survival analysis of the wheat germination data. 22nd International Conference. Information Technology Interfaces ITI 2000. June, 2000, Pula, Croatia.

Hadush T, Gebresilassie B (2012). The effect of salinity (NaCl) on germination of selected Grass pea (*Lathyrus sativus* L.). Landraces of Tigray. Asian J. Agric. Sci. 4:96-101.

Houle GL, Morel L, Reynolds CE, Seigel J (2001). The effect of salinity on different developmental stages of an endemic annual plant, *Asterlaurenti anus*. Am. J. Bot. 88:62-67.

Kandil AA, Sharief AE, Ahmed SRH (2012). Germination and Seedling Growth of Some Chickpea Cultivars (*Cicer arietinum* L.) under salinity stress. J. Basic Appl. Sci. 8:561-571.

Kaya MD, Kaya G, Kolsarici O (2005). Effects of NaCl concentration on germination and emergence of some *Brassica* species. J. Agric. Sci. 11:448-452.

Kaydan D, Yagmur M (2008). Germination, seedling growth and relative water content of shoot in different seed sizes of triticale under osmotic stress of water and NaCl. Afr. J. Biotechnol. 7:2862-2868.

Kaymakanova M (2009). Effect of salinity on germination and seed physiology in bean (*Phaseolus vulugaris* L.). Biotechnol. 23:326-329.

Khajeh-Hosseni MA, Powell A, Bingham IJ (2003). The interaction between salinity Stress and seed vigour during germination of soybean seeds. Seed Sci. Technol. 31:751-725.

Khan HA, Ayub CM, Pervez MA, Bilal RM, Shahid MA, Ziaf K (2009). Effect of seed priming with NaCl on salinity tolerance of hot pepper (*Capsicum annuum* L.) at seedling stage. Soil Environ. 28:81-87.

Khayatnezhad M, Gholamin R (2011). Effects of salt stress levels on five maize (Zea mays L.) cultivars at germination stage. Afr. J. Biotechnol. 10:12909-12915.

Kitajima K, Fenner M (2000). Ecology of seedling regeneration. J. Plant Cell Environ. 25:239-250.

Le Rudulier D (2005). Osmoregulation in Rhizobia: The key role of compatible solutes. Grain Legume 42:18-19.

Lewis G, Schrirer B. Mackinder B (2005). *Legumes of the World*; Royal Botanical Gardens. Kew, UK.

Li Y (2008). Effect of salt stress on seed germination and seedling growth of three Salinity plants. Pak. J. Biol. Sci. 11:1268-1272.

Mahdavi B, Sanavy SAMM (2007). Germination and seedling growth in grass pea (*Lathyrus sativus*) cultivars under salinity conditions. Pak. J. Biol. Sci.10:273-279.

Mohammadi H, Poustini K, Ahmadi A (2008). Root nitrogen remobilization and ion status of two alfalfa (*Medicago sativa* L.) cultivars in response to salinity stress. J. Agron. Crop Sci. 194:126-134.

Morris B, Charles S, Son S (2003). Legumes. In: Solomon HK (ed.). *Encyclopedia of Food and Culture*. New York.

Munns R, James RA, Läuchli A (2006). Approaches to increasing the salt tolerance of wheat and other cereals. J. Exp. Bot. 57:1025-1043.

Patto MC (2009). Genetics, genomics and breeding in crop plants. In: *Cool season Legumes*. Science Publication. Plymouth, UK.

Pessarakli M, Kopec DM (2009). Screening various Ryegrass cultivars for salt stress tolerance. J. Food Agric. Environ. 7:739-743.

Rahman M, Soomro U, Zahoor-ul-Hag M, Gul Sh (2008). Effects of NaCl salinity on Wheat (*Triticum aestivum* L.) cultivars. World J. Agric. Sci. 4:398-403.

Turan MA, Turkmen N, Taban N (2007). Effect of NaCl on stomatal resistance and proline, chlorophyll, Na, Cl and K concentration of lentil plants. J. Agron. 6:378-381.