AJA. VOL (2) ISSUE 5, 2015: 138-141

Azarian Journal of Agriculture

www.azarianjournals.ir

Azarian Journals

Short communication

ISSN:2383-4420

Evaluation of salinity stress effects on seed yield and quality of three soybean cultivars

Ayman El-Sabagh[1*], Sobhy Sorour[1], Akihiro Ueda[2], Hirofumi Saneoka[2] and Celaleddin Barutçular[3]

Article Info

Accepted:
10 Oct. 2015

Keywords:
Glycine max L., seed oil, protein, salt stress, yield

ABSTRACT

Salinity is a widespread soil problem limiting productivity of oilseed crops worldwide and soybean cultivars differ in their sensitivity to soil salinity. With this in mind, a pot experiment was conducted at plant nutritional physiology laboratory, Hiroshima University, Japan to study the response of three Egytp soybean cultivars (Giza-111, Giza-82 and Giza-35) to salinity stress (Control, 10 mM NaCl). The results showed that the culivars had a negative responce to salinity stress and most of the measured plant yield traits, oil and protein content. Results indicated that Giza-111 cultivar surpassed other cultivars in all characters under study. The highest value of seed yield, seed oil and protein percent observed in Giza-111 with the compare to other cultivars under salinity conditions. It was concluded that soybean is a sensitive plant to salinity stress, but the extent of this sensitivity varies among cultivars. As a result, Giza-111 cultivar showed more capability to survive under salinity condition compared with another cultivars regarding of almost all plant traits examined. Considering, Giza-111 was found more appropriate under salinity condition.

INTRODUCTION

Agricultural productivity in arid and semi-arid regions of the world is very low due to accumulation of salts in soils (Munns 2002). Plants tend to be exposed to many stress factors, such as drought, high salinity or pathogens, which reduce the yield of the cultivated plants or affect the quality of the harvested products (Arafa et al. 2009). Salt stress can directly or indirectly affect the physiological status of plants by disturbing their metabolism, growth, development and productivity (Zhu 2001). Salinity causes a number of changes in plant metabolism, through ion toxicity and osmotic stress (Mittler 2002).

Soybean (*Glycine max* L.) is a strategic crop plant grown to obtain edible oil and forage. High sensitivity to soil and water salinity is one of the biggest problems with soybean crop. Results have indicated that salinity affects growth and development of plants through osmotic and ionic stresses. Because of accumulated salts in soil under salt stress condition plant wilts apparently while soil salts such as Na^+ and Cl^- disrupt normal growth and development of plant (KhajehHosseini et al. 2003; Farhoudi et al. 2007).

The agronomic traits of soybean could be severely affected by high salinity, including reduction in height, leaf size, biomass, number of internodes, number of branches, number of pods, weight per plant, and weight of 100 seeds (Chang et al. 1994). In general, salt stress reduces the protein contents in soybean seeds (Chang et al. 1994; Wan et al. 2002). However, the effect of salt on oil content of soybean seeds is still inconclusive since experimental results varied in different field sites using different cultivars treated with differentsalinity levels (Chang et al. 1994; Wan et al. 2002). However, soybean growth is severely suppressed and yield decreases dramatically under salt stress (Katerji et al. 2003). Soybean production may be limited by environmental stresses such as soil salinity (Ghassemi-Golezani et al. 2009). As more and more agricultural lands are affected by soil salinity, soybean production is being threatened. Thus, it is very important to breed salt-tolerant soybean cultivars (Lee et al. 2009). Therefore, the present study to compare the salinity stress adaptations in three different soybean cultivars in order to identify the soybean cultivar

1- Department of Agronomy, Faculty of Agriculture, Kafrelsheikh University, Egypt
2- Laboratory of plant nutritional physiology, Graduate School of Biosphere Science, Hiroshima University, Japan
3- Department of Field Crops, Faculty of Agriculture, Cukurova University, Turkey
*Email: aymanelsabagh@gmail.com

with a better performance even under saline conditions for enhancing soybean production in newly reclaimed soils of Egypt.

MATERIALS AND METHODS

The experiment was conducted at plant nutritional physiology laboratory, Hiroshima University in Japan during 2011. The seeds of soybean (*Glycine max* L.) cultivars (Giza-111, Giza-82 and Giza-35) were obtained from Agricultural Research Center,Egypt. The seeds were sown into plastic pots and filled with 12 kg of mixture of granite regosol soil and perlite (2:1:1, v/v). Plants were irrigated with nutrient solution at each watering using an irrigation system. The basal nutrient solution contained 8.3 mM NO_3-N, 0.8 mM NH_4-N, 0.5 mM P_2O_5, 2.2 mM K_2O, 0.7 mM MgO, 2.1 mM CaO, 11 µM MnO, 5 µM B_2O_3, and 13 µM Fe. Each pot was fertilized at a rate of 40 kg N/ha, 120 kg P_2O_5/ha and 100 kg K^2O^5/ha using fertilizer mixture and soil pH was adjusted to 6.0 with dolomitic calcium carbonate (300 kg/ha). The experiment was designed as a completely randomized block design with five replication. All pots were randomly located in the greenhouse in order to avoid to positional effects. The treatments consisted of three soybean cultivars and two salinity levels (control, 10 mM NaCl).Tap water was used as control. Saline application was started from sowing to harvest. The Seeds were sown in uniformed pots filled with 12 kg soil. Three plants were retained in each pot.

Plant sampling Measurement

At seed maturity, the three plants per replication were harvested in order to determine: number of branches per plant, number of pods/plant, 100 seed weight and seed yield/plant. Seed protein (%);Total nitrogen determined by Kjeldahl method according to AOAC (1980) and the crude protein was calculated by multiplying nitrogen percentage by converting factor 6.25 (Robinson 1975). Oil content; Oil content of seed was estimated according to AOCS (1980) using soxhelt apparatus and petroleum ether (40-60˚C) as a solvent.

The data were analyzed by MSTAT-C software and all data collected were subjected to analysis of variance according to Gomez and Gomez (1984) and treatment means were compared using Duncun Multiple Range Test (Duncan 1955).

RESULTS AND DISCUSSION

In the experiment, efforts were made to find out the effect of salt stress on yield and quality contributing parameters of three soybean cultivars. Detailed discussions on the results presented in this chapter have been made under the following heads.

Number of branches per plant

Salinity stress led to a significant reduction in number of branch per plant over control and G111 had the highest number of branch per plant than that of G35 and G82 cultivars (Table 1). Similar result was reported by Islam et al. (2012), who found that decrement of branch number of lentil under salinity level. This might be due to salinity inhibits the formation of new branch and facilitating the aging of old branch at various degrees .

Number of Pods per plant

Data in (Table 1) indicated that salinity stress lead to a significant reduction in number of pods per plant over control and G111 produced the highest number of pods per plant than that of G35 and G82.cultivars. Salinity stress significantly reduced pods per plant in soybean. These results agree with Chang et al. (1994) who reported that, the agronomic traits of soybean could severely be affected by under salinity, including reduction in number of pods. Moreover, Taffouo et al. (2009) who reported that, the significant decrease of yield components under salt stress in cowpea would be partly related to a significant reduction of foliar chlorophyll contents in saline medium.

Table 1.The effects of salinity on number of branches per plant, number of pods per plant,100-seed weight (g) and seed yield per plant (g) in soybean cultivars

Cultivars	Treatments	Number of branches per plant	Number of pods per plant	100-seed weight (g)	seed yield per plant (g)
Giza 35	Control	5.7 a	28.5 b	15.5 b	15.1 a
	10 mM (NaCl)	3.5 c	15.8 d	8.0 e	4.8 c
Giza 82	Control	5.2 a	35.8 a	17.8 a	15.6 a
	10 mM (NaCl)	3.9 c	17.7 d	9.2 d	5.3 c
Giza 111	Control	5.6 a	37.8 a	18.7 a	15.3 a
	10 mM (NaCl)	4.6 b	24.0 c	13.1 c	8.9 b

Table 2.The effects of salinity on oil (%) and protein (%) in soybean cultivars

Cultivars	Treatments	Oil (%)	Protein (%)
Giza 35	Control	22.0 b	43.0 a
	10 mM (NaCl)	9.8 e	29.5 d
Giza 82	Control	19.2 c	39.5 b
	10 mM (NaCl)	9.0 e	28.9 d
Giza 111	Control	24.0 a	42.7 a
	10 mM (NaCl)	14.0 d	33.3 c

100-seed weight

The 100 -seed weight decreased significantly under salinity stress (Table 1). This stress at pod filling stage can cause a decrease in the photosynthate mobilization to grains and thereby decreasing grain weight (Sadeghipour 2008). Decreasing seed weight of lentil under salinity may be attributed to the reduction of carbon metabolism (Balibrea et al. 2000). These results are in agreement with those reported for soybean (Soussi et al. 1998).

Seed yield per plant

The analysis of variance for seed yield per plant showed that seed yield decreased significantly with increasing salinity levels and a greater reduction was observed in G82 and G35, respectively (Table 1). Reductions in grain yield as a result of salt stress have also been reported for chickpea (Sohrabiet et al. 2008) and soybean (Ghassemi-Golezaniet et al. 2011).

Oil percentage

Data showed that the effect of salt stress on oil content was significant. Cultivar Giza82 and G35 more severely affected than Giza111 (Table 2). Mean comparisons showed that the lowest oil percentage was obtained in salt stress is consistent with the result of Zadeh and Naeini (2007), who reported that these reductions may be attributed to the weakening of salinity to protein – pigment – lipid complex or enzyme activities. This was associated with production of larger grains under non-saline conditions (Ghassemi-Golezani et al. 2009).

Protein percentage

Data in (Table 2) indicated that salinity stress lead to a significant reduction in protein percent and the cultivar Giza82 and G35 more badly affected than Giza111. Reduction in protein content under salinity stress also may be due to the disturbance in nitrogen metabolism or inhibition of nitrate absorption as reported by El-Zeiny et al. (2007). Medhat (2002) reported that salinity stress induce changes in the ion content of plant cell which intern induce changes in the activity of certain metabolic systems that might have serious consequences for protein.

CONCLUSION

Salinity stress can considerably reduce growth and consequently grain yield per plant in soybean cultivars. These reductions enhance under salinity stress. Oil and protein contents of soybean cultivars decrease under salinity. This results suggest that Giza-111 showed a better performance under salinity stress and more appropriate under salinity condition and recommended to use in breeding program for enhancing soybean production in newly reclaimed soils of Egypt.

REFERENCES

AOAC (1980) Association of official agriculture chemists “official methods of analysis” 13th Edition, Washington, DC, USA.

Arafa A. A. Khafagy M.A. El-Banna M. F. (2009) The effect of glycine betaine or ascorbic acid on grain germination and leaf structure of sorghum plants grown under salinity stress. Australian Journal of Crop Science, 5: 294-304.

Ashraf M. (1994) Breeding for salinity tolerance in plants. Critical Reviews in Plant Science, 13: 17-42.

Balibrea M. E. Dell Amico J. Bolarin M. C. Perz-alfocea F. (2000) Carbon partitioning and sucrose metabolism in tomato plants growing under salinity. Journal of plant physiology, 10: 503-11.

Chang R. Z. Chen Y. W. Shao G. H. Wan C. W. (1994) Effect of salt stress on agronomic characters and chemical quality of seeds in soybean. Soybean Science, 13: 101-105.

Duncan B. D. (1955) Multiple range and multiple F. Test. Biometrics, II: 1- 42.

El Zeiny H. A. Abou L. B. Gaballah M. S. Khalil S. (2007) Antitranspirant application to sesame plant forsalinity stress Augmentation. Journal of Agricultural and Biological Science, 3: 950 – 959.

Farhoudi R. Sharifzadeh F. Poustini K. Makkizadeh MT. Kochakpour M. (2007) The effects of NaCl priming on salt tolerance in canola (Brassica napus) seedlings grown under

saline conditions. Seed Science and Technology, 35: 754-759
Ghassemi-Golezani K. Ghanehpoor S. Dabbagh M. N. A. (2009) Effects of water limitation on growth and grain filling of faba bean cultivars. Journal of Food, Agriculture and Environment, 7: 442-447.
Ghassemi-Golezani K. Taifeh-Noori M. OustanSh S. Moghaddam M. Seyyed-Rahmani S. (2011) Physiological performance of soybean cultivars under salinity stress. Journal of Plant Physiology Breeding, 1: 1-8.
Gomez K. A. and Gomez A. A. (1984) Statistical procedures for agricultural research. John Wiley and Sons, New York. 2nd edition, paperback, pp. 680.
Islam M. T. Jahan N. A. Sen A. K. Pramanik M. H. R. (2012) Effects of salinity on morpho physiological attributes and yield of lentil genotypes. International Journal of Sustainable Crop Production, 1:12-18.
Katerji N. Hoorn J. W. Hamdy A. Mastrorilli M. (2003) Salinity effect on crop development and yield, analysis of salt tolerance according to several classification methods. Agriculture Water Management, 62: 37-66.
Khajeh-Hosseini M. Powell AA. Bingham I. J. (2003) The interaction between salinity stress and seed vigour during germination of soybean seeds. Seed Science and Technology, 31: 715–725.
Lee J. D. Shannon J. G. Vuongand T. D. Nguyen H. T. (2009) Inheritance of salt tolerance in wild soybean (Glycine soja Sieb. and Zucc.) accession PI483463. Journal of Heredity, 100: 798–801.
Medhat M. T. (2002) Comparative study on growth, yield and nutritive value for some forage plants grown under different levels of salinity. Ph.D. Thesis Faculty of Science, Botany Department, Cairo University, Egypt.
Mittler R. (2002) Oxidative stress, antioxidants and stress tolerance. Trends Plant Science, 7: 405-410.
Munns R. (2002) Comparative physiology of salt and water stress. Plant Cell and Environment, 25: 239-250.
Robinson R. G. (1975) Amino acids and elemental composition of sunflower and pumpkin seeds. Agronomy Journal, 61: 541.
Sadeghipour O. (2008) Effect of withholding irrigation at different growth stages on yield and yield components of mung bean (*Vicia radiata* L. Wilezek) varieties. American Eurasian Journal of Agriculture and Environmental Sciences, 4: 590-594.
Sohrabi Y. Heidari G. H. Esmailpoor B. (2008) Effect of salinity on growth and yield of desi and kabuli chickpea cultivars. Pakistan Journal of Biological Sciences, 11: 664-667.
Soussi M. Ocana A. Liuch C. (1998) Effects of salt stress on growth, photosynthesis and nitrogen fixation in chickpea (*Cicer arietinum* L.). Journal of Experimental Botany, 49: 1329-37.
Taffouo V. D. Kouamou J. K. Ngalangue L. M. T. Ndjeudji B. A. N. Akoa A. (2009) Effects of salinity stress on growth, ion partitioning and yield of some cowpea (*Vigna unguiculata* L. Walp.) cultivars. International Journal of Botany, 5(2): 135-143.
Wang D. Shannon M. C. Grieve C. M. Shouse P. J. Suarez D. L. (2002) Ion partitioning among soil and plant components under drip, furrow, and sprinkler irrigation regimes: field and modeling assessments. Journal of Environmental Quality, 31: 1684-1693.
Zadeh H. M. Naeini M. B. (2007) Effects of salinity stress on the morphology and yield of two cultivars of canola (*Brassica napus* L.). Journal of Agronomy, 6(3): 409-414.
Zhu J. K. (2001) Plant salt tolerance. Trends Plant Science, 2: 66-71.

Journal sponsorship

Azarian Journal of Agriculture is grateful to the ***University of Maragheh*** and its faculty members for their ongoing encouragement, support and assistance.