Reprint ISSN 1923-7766 (Web Version)

International Journal of Experimental Agriculture

(Int. J. Expt. Agric.)

Volume: 8	Issue: 1	March 2018

Int. J. Expt. Agric. 8(1): 15-18 (March 2018)

PHOTOSYNTHESIS, DRY MATTER PRODUCTION AND YIELD OF SOYBEAN GENOTYPES UNDER DIFFERENT SALINITY LEVELS

R. MONDAL, M.T. ISLAM, B.S. NAHAR AND S. KHANAM

An International Scientific Research Publisher

Green Global Foundation©

Web address: http://ggfjournals.com/e-journals archive
E-mails: editor@ggfjournals.com and editor.int.correspondence@ggfjournals.com

ISSN-1923-7766 (Online)
Int. J. Expt. Agric. 8(1):15-18(March 2018)

PHOTOSYNTHESIS, DRY MATTER PRODUCTION AND YIELD OF SOYBEAN GENOTYPES UNDER DIFFERENT SALINITY LEVELS

R. MONDAL[1], M.T. ISLAM[2*], B.S. NAHAR[3] AND S. KHANAM[2]

[1]Former MS student, Department of Environmental Sciences, Bangladesh Agricultural University (BAU), Mymensingh; [2]Crop Physiology Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh; [3]Center for Environmental Sciences, BAU, Mymensingh.

*Corresponding author & address: Dr. Md. Tariqul Islam, E-mail: islamtariqul05@yahoo.com
Accepted for publication on 28 February 2018

ABSTRACT

Mondal R, Islam MT, Nahar BS, Khanam S (2017) Photosynthesis, dry matter production and yield of soybean genotypes under different salinity levels. *Int. J. Expt. Agric.* 8(1), 15-18.

Salinity seriously threatens crop production in arid and semi-arid regions. A pot experiment was conducted at the Bangladesh Institute of Nuclear Agriculture, Mymensingh during January to May 2016 to investigate the effect of salinity at different growth stages on morphological characters, yield attributes and yield of three soybean genotypes *viz*. Binasoybean-4, SBM-18 and Binasoybean-3. Salinity of 3 and 6 dSm^{-1} was imposed at pre-flowering stage of the soybean genotypes along with a control. The experiment was laid out in a Completely Randomized Design with three replications. Photosynthesis, chlorophyll content, nitrate reductase activity, plant height, number of branches per plant, number of leaves per plant, total dry matter, number of pods per plant, number of seeds per pod, seed, 100-seed weight and seed yield were gradually reduced with increasing level of salinity as compared to those of control. Plant height decreased more in SBM-18 by higher salinity level (6 dSm^{-1}) compared to control. Under the treatments, Binasoybean-4 showed the highest number of seeds per pod, total dry matter and seed yield per plant. SBM-18 produced the highest number of leaves and pods per plant with the lowest total dry matter. Binasoybean-3 showed the highest plant height and total dry matter but the lowest seed yield per plant. Among the genotypes, Binasoybean-4 and SBM-18 performed better than Binasoybean-3 under salt stress.

***Key words**: salinity, photosynthesis, yield attributes, soybean*

INTRODUCTION

Salinity is one of the major widespread environmental stresses that can limit growth and development of salt sensitive plant (Greenway and Munns, 1980). According to the report of FAO (2010), over 800 million ha of worldwide land are severely salt affected and approximately 20% of irrigated areas (about 45 million of ha) are estimated to suffer from salinity problems by various degrees. This is more serious since irrigated areas are responsible for one-third of world's food production. In Asia 21.5 million ha of land areas are affected by salinity and estimated to cause the loss of up to 50% fertile land by the 21st mid-century (Nazar 2011). More than 30% of the cultivable land in Bangladesh is in coastal area. Out of 2.68 million ha of coastal and off-shore lands, about 1.056 million ha of arable lands are affected by varying degrees of salinity (SRDI 2010).

Soybean (*Glycine max* L. Merrill) is an annual crop of *Fabaceae* and is considered as the most important legume crop in the world. Soybean is one of the most economic and nutritious crops, as it contains high protein and oil (Yaklich *et al.* 2002). The oil created from soybean is extremely eatable and contains no steroid alcohol. Growth, development and yield of soybean are the results of genetic potential interacting with atmosphere. Soybean seed production may be restricted by environmental stresses like soil salinity. Soil salinity, ensuing from natural processes or from crop irrigation with saline water, occurs in several arid and semi-arid regions of the globe. Approximately 18 to 21% of soybean dry seed weight is oil in the form of tri-acylglycerol. The seed contains approximately 20% oil and 40% protein (Luo *et al.* 2005). Salinity is one of the major widespread environmental stresses that can limit growth and development of salt sensitive plant (Greenway and Munns, 1980). The term "salinity" represents all the problems of the soil accumulating excessive salts, which can be categorized into sodic (or alkaline) and saline soils. Due to its high super molecule and oil content, soybean is a very important harvest for human diet, animal feeds, and biodiesel. It's conjointly used as staple for several human health and industrial product. Therefore, the demand of soybean is ever increasing worldwide. Salt stress is one in every of the abiotic stresses that considerably scale back the yield of soybean. The objectives of the study were to observe the effect of salinity stress on growth and yield of soybean genotypes and to identify relative salt tolerant soybean genotype among them.

MATERIALS AND METHODS

The experiment was conducted at the pot yard of Bangladesh Institute of Nuclear Agriculture, Mymensingh during 10 January to 10 May 2016 with a view to evaluate three soybean genotypes. Three genotypes of soybean namely Binasoybean-4, SBM-18 and Binasoybean-3 were grown in pot under different levels of salinity 3, 6 dSm^{-1} along with a control (no salt was added) to investigate their growth, yield and yield attributes. The soil of the experiment was collected from BINA farm, Mymensingh. The collected soil was dried under the sun and was crushed and sieved. Cowdung (4 kg) was mixed with the collected soil and each of the pots was filled with 10 kg of soil. Urea, TSP (Triple Super Phosphate), MP (Murat of Potash) and gypsum were applied @ 50, 150, 100 and 80 kg ha^{-1} respectively. The pots were placed in the BINA experimental field. This is a two factorial experiment in a Completely Randomized Design (CRD) with three replications. Three treatments were given by adding different amounts of sodium chloride salt solution to pot soils. The required amount of salt was applied at pre-flowering stage to develop 2 salinity levels *viz*. 3 dSm^{-1} and 6 dSm^{-1} along with control (no salt was added). Salinity was measured by electrical conductivity meter. Data on photosynthesis, leaf conductance and transpiration were measured by Portable Photosynthesis System (Li-6400XT) and chlorophyll by SPAD meter. The nitrate reductase activity of leaf was assayed and measured following the method of Stewart and Orebamjo (1979). Plant samples were harvested at pod formation stage and maturity stage and data on growth, yield attributes and yield were recorded. Data were analyzed using the MSTAT-C package (Russell 1986) where mean differences were compared by DMRT.

RESULTS AND DISCUSSION

It was observed that plant height, number of branches per plant, number of leaves and total dry matter per plant, photosynthesis, transpiration, chlorophyll content and nitrate reductase activity decreased with increasing soil salinity levels compared to that of control. Yield attributes like number of pods, pod weight, 100-seed weight, seed yield etc. also decreased with increasing salinity compared to that of control. The highest vegetative growth, yield and yield contributing characters were obtained at control condition and the lowest of those were found at 6 dSm^{-1} salinity level. Decreased plant height, dry matter, yield and yield attributes under salinity stress were also reported by many authors (Maher *et al.* 2003; Islam *et al.* 2006; Sarker 2007). The results are in conformity with Kaymakanova and Stoeva (2008) who reported that the salinity on plant reduced in photosynthesis and photosynthetic apparatus through inducing stomata closure. Islam *et al.* (2007) found that total chlorophyll content was reduced with increased levels of salinity. The results of the reduction of NR activity in soybean due to salinity is supported by the works of Khan (1996).

Plant height, number of branches per plant, number of leaves per plant, photosynthesis, chlorophyll content, transpiration, nitrate reductase, stem weight, leaf weight, total dry matter, number of pods per plant, number of seeds per plant, 100-seed weight and seed yield were significant among the studied genotypes. Binasoybean-4 showed the highest stem weight, total dry matter, seeds per pod and seed yield. The genotypes SBM-18 showed the highest photosynthesis, chlorophyll content, number of leaves and pods per plant and lowest 100-seed weight. Binasoybean-3 showed the highest plant height, 100-seed weight and lowest chlorophyll content and pod per plant.

Interaction between salinity and genotypes had significant effect on plant height, number of branches per plant, number of leaves per plant, photosynthesis, chlorophyll content, nitrate reductase, stem weight, leaf weight, total dry matter, number of pods per plant, number of seeds per plant, 100-seed weight and seed yield. Nitrate reductase, number of branches per plant, stem weight, total dry matter per plant, pods per plant, seed per pod and seed yield showed the highest result in the treatment combination of Binasoybean-4×control. Plant height, leaf weight, 100-seed weight showed the highest result in the treatment combination of Binasoybean-3×control. Number of leaves showed the highest result in the treatment combination of SBM-18×control. Number of pods per plant, chlorophyll content, nitrate reductase activity, and seed yield per plant showed the lowest result in the treatment combination of Binasoybean-3×6 dSm^{-1}. Total dry matter, stem weight and number of seeds per pod showed the lowest result in the treatment combination of SBM-18×6 dSm^{-1}.

Table 1. Variation in morphological and physiological parameters of soybean genotypes under different salinity levels at 90 DAS

Treatments	Morphological parameters			Physiological parameters			
	Plant height (cm)	Branches $plant^{-1}$ (no.)	Leaves $plant^{-1}$ (no.)	Root weight $plant^{-1}$ (g)	Stem weight $plant^{-1}$ (g)	Leaf weight $plant^{-1}$ (g)	Total dry mass $plant^{-1}$ (g)
Salinity levels							
Control	77.33 a	7.66 a	79.55 a	3.08 ns	37.52 a	23.56 a	64.16 a
3 dSm^{-1}	68.88 b	6.11 b	70.55 b	3.04	34.76 a	19.48 ab	57.28 b
6 dSm^{-1}	59.00 c	6.00 b	54.77 c	2.78	27.74 b	19.14 b	49.68 c
Genotypes							
Binasoybean-4	62.33 b	6.88 ns	63.55 b	2.95 ns	35.74 a	20.98 ns	59.68 a
SBM-18	61.11 b	6.44	76.66 a	2.83	30.34 b	19.02	52.20 b
Binasoybean-3	81.77 a	6.44	64.66 b	3.12	33.93 ab	22.18	59.24 a

In a column, with in treatment, common letter(s) do not differ significantly at 5% level as per DMRT

Table 2. Interaction of genotypes and salinity level on total dry matter and its distribution at 90 DAS

Genotypes × Salinity		**Root weight plant^{-1} (g)**	**Stem weight plant^{-1} (g)**	**Leaf weight plant^{-1} (g)**	**Total dry mass plant^{-1} (g)**
Binasoybean-4	Control	3.07	39.51 a	22.69 ab	65.28 a
	3 dSm^{-1}	3.34	33.87 ab	21.32 ab	56.54 abc
	6 dSm^{-1}	2.44	33.84 ab	18.94 ab	55.22 bc
SBM-18	Control	2.93	38.30 a	21.78 ab	63.02 abc
	3 dSm^{-1}	2.82	31.74 ab	19.49 ab	54.06 c
	6 dSm^{-1}	2.74	20.99 c	15.80 b	39.53 d
Binasoybean-3	Control	3.23	34.75 ab	26.21 a	64.19 ab
	3 dSm^{-1}	2.96	38.66 a	17.64 b	59.26 abc
	6 dSm^{-1}	3.18	28.40 bc	22.69 ab	54.28 c

Common letter(s) in a column do not differ significantly at 5% level as per DMRT

Table 3. Photosynthesis, leaf conductance, transpiration rate, chlorophyll and nitrate reductase activity of soybean genotypes under salinity levels

Treatments	**Photosynthesis (µmol CO_2m^{-1} s^{-1})**	**Leaf conductance (m mol H_2O m^{-2} s^{-1})**	**Transpiration (m mol H_2O m^{-2} s^{-1})**	**SPAD reading (Chlorophyll)**	**Nitrate reductase activity (NO_2^- g^{-1}fw h^{-1})**
Salinity levels					
Control	38.96 a	0.23 a	4.40 a	36.29 a	1.53 a
3 dSm^{-1}	36.78 b	0.16 a	3.30 b	35.11 b	1.36 ab
6 dSm^{-1}	34.54 c	0.20 a	2.44 c	33.10 c	1.16 b
Genotypes					
Binasoybean-4	35.97 b	0.17 a	3.36 a	34.86 b	1.52 a
SBM-18	40.28 a	0.17 a	3.29 a	35.86 a	1.55 a
Binasoybean-3	34.01 c	0.26 a	3.48 a	33.79 c	0.98 b

Common letter(s) in a column within treatment indicate do not differ significantly at 5% level as per DMRT

Table 4. Interaction of genotypes and salinity on photosynthesis, leaf conductance, transpiration rate, chlorophyll and nitrate reductase activity

Genotypes × Salinity		**Photosynthesis (µmol CO_2m^{-1}s^{-1})**	**Leaf conductance (m mol H_2O m^{-2}s^{-1})**	**Transpiration (m mol H_2O m^{-2}s^{-1})**	**SPAD reading (Chlorophyll)**	**Nitrate reductase activity (NO_2^- g^{-1}fw h^{-1})**
Binasoybean-4	Control	37.23 c	0.24	4.40 a	35.93 bc	1.68 a
	3 dSm^{-1}	36.23 cd	0.16	3.21 b	35.16 d	1.46 ab
	6 dSm^{-1}	34.47 d	0.12	2.48 c	33.46 e	1.43 abc
SBM-18	Control	44.07 a	0.23	4.45 a	36.87 a	1.71 a
	3 dSm^{-1}	39.73 b	0.16	3.19 b	35.40 bcd	1.52 ab
	6 dSm^{-1}	37.07 c	0.11	2.24 c	35.30 cd	1.42 abc
Binasoybean-3	Control	35.57 cd	0.23	4.36 a	36.07 b	1.21 bc
	3 dSm^{-1}	34.37 d	0.15	3.50 b	34.77 d	1.08 c
	6 dSm^{-1}	32.10 e	0.10	2.60 c	30.53 f	0.65 d

Common letter(s) in a column do not differ significantly at 5% level as per DMRT; ns, not significant

Table 5. Yield and yield contributing characters of soybean genotypes under different salinity levels

Treatments	**Pods plant^{-1} (no.)**	**Seeds pod^{-1} (no.)**	**100-seed weight (g)**	**Seed weight plant^{-1} (g)**
Control (T_0)	67.56 a	2.47 a	10.40 a	17.58 a
3 dSm^{-1} (T_1)	59.56 b	2.30 b	10.08 b	13.85 b
6 dSm^{-1} (T_2)	56.00 c	2.12 c	9.42 c	11.27 c
Genotypes				
Binasoybean-4	63.11 b	2.36 a	9.93 ab	15.16 a
SBM-18	65.66 a	2.24 b	9.85 b	14.77 a
Binasoybean-3	54.33 c	2.28 b	10.13 a	12.77 b

Common letter(s) in a column do not differ significantly at 5% level as per DMRT

Table 6. Interaction of genotypes and salinity on yield and yield contributing characters

Genotypes × Salinity		Pods plant^{-1} (no.)	Seeds pod^{-1} (no.)	100-seed weight (g)	Seed weight plant^{-1} (g)
Binasoybean-4	Control	75.00 a	2.50 a	10.47 ab	19.76 a
	3 dSm^{-1}	59.00 de	2.40 ab	10.11 bc	14.38 c
	6 dSm^{-1}	55.33 e	2.20 c	9.22 e	11.33 ef
SBM-18	Control	70.67 b	2.53 a	10.16 bc	18.37 b
	3 dSm^{-1}	64.67 c	2.20 c	9.80 cd	14.03 cd
	6 dSm^{-1}	61.67 cd	2.00 d	9.59 de	11.91 e
Binasoybean-3	Control	57.00 e	2.40 ab	10.59 a	14.62 c
	3 dSm^{-1}	55.00 e	2.30 bc	10.33 ab	13.15 d
	6 dSm^{-1}	51.oo f	2.16 c	9.46 de	10.55 f

Common letter(s) in a column on specific treatment do not differ significantly at 5% level as per DMRT

CONCLUSION

Yield and yield attributes of Binasoybean-4 genotype was the highest at the control and this was decreased with increasing salinity. Considering the performance of three soybean genotypes under salt stress Binasoybean-4 andSBM-18 performed better than Binasoybean-3.

REFERENCES

Food and Agriculture Organization (2010) Report of salt affected agriculture. http://www.fao.org/ag/agl/agll/spush/.

Greenway H, Munns R (1980) Mechanism of salt tolerance in non-halophytes. Ann. Rev. *Plant Physiol*. 31: 149-190.

Islam MT, Rashid MA, Razzaque AHM (2006) Effect of salinity on morphological attributes and yield of lentil. *J. Bangladesh Soc. Agric. Sci. Technol*. 3: 149-151.

Islam MZ, Baset MA, Akter A, Rahman MH (2007) Biochemical attributes of mutant rice under different saline levels. *Int. J. Sust. Crop Prod*. 2(3), 17-21.

Kaymakanova M, Stoeva N (2008) Physiological reaction of bean plants (*Phaseolus vulg*. L.) to salt stress. *Gen. Appl. Plant Physiol*. Special Issue, 34(3-4), 177-188.

Khan MG (1996) Nitrate and nitrate reductase activity in soybean plants raised with saline water. *Indian J. Plant physiol*. 1(2), 121-129.

Luo Q, Yu B, Liu Y (2005) Differential sensitivity to chloride and sodium ions in seedlings of *Glycine max* and *G. soja* under NaCl stress. *J. Plant Physiol*.162: 1003-1012.

Maher L, Armstrong R, Connor D, Unkovich M, Learey OG (2003) Salt tolerant lentils a possibility for the future solutions for a better environment. Proc. 11th Australian Agron.Conf. Geelong Victoria Australia. 2-6 February, 2003.

Nazar S, Courtois B, Ahmadi N, Abreu I, Saibo N, Oliveira MM (2011) Recent updates on salinity stress in rice: from physiological to molecular responses. *Critical Reviews in Plant Sciences*, vol. 30, no. 4, pp. 329–377.

Russell DF (1986) MSTAT Director, Crop and Soil Sci. Dept., Michigan State University, USA.

Sarker MA (2007) Yield performance of lentil genotypes under salinity. M. S. Thesis, Dept. of Crop Botany. Bangladesh Agril. Univ., Mymensingh.

SRDI (2010) Saline soils of Bangladesh. Soil Resource Development Institute, Dhaka.

Stewart GR, Orebamjo TO (1979) Some unusual characteristics of nitrate reduction in *Erythrana senegalensis*. *New Phytol*. 83: 34-319.

Yaklich RW, Vinyard B, Camp M, Douglass S (2002) Analysis of seed protein and oil from soybean northern and southern region uniform tests. *Crop Sci*., 42: 1504–1515.