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EFFECTS OF SOIL SALINITY ON THE YIELD AND YIELD COMPONENTS OF MUNGBEAN

Shakil Ahmed

Environment and Myco-technology Research Lab., Department of Mycology & Plant Pathology, University of the Punjab, Quaid e Azam Campus, Lahore-54590, Pakistan; E.-mail: shakil@mpp.pu.edu.pk; shakil786gcl@yahoo.com

ABSTRACT

Experiment was conducted with five mungbean genotypes with the aim of ascertaining the effects of salt stress on the yield and its component. The decrease in seed yield per plant under salt stress was more pronounced associated with a reduced number of seed per pod and 100 seed weight. Consequently salt stress was more effective at vegetative, flowering and seed filling stages rather than seed development stage in all the five genotypes. NM-92 was less affected which showed its adaptability under saline conditions. Delayed maturity due to salt stress pushes the plant also be desiccation stress causing shriveled seeds.

Keywords: Economic yield, growth stages, sodium chloride, *Vigna radiata*.

INTRODUCTION

Salinity is known to reduce the growth of glycophytes (salt sensitive species). Salinization of soil is one of the major factors limiting crop production, particularly in arid and semi-arid regions of the world, like Pakistan. It occupies a prominent placed amongst the soil problems that threaten the sustainability of agriculture in Pakistan. Out of 16.2 m ha of land under irrigation, more than 40,000 ha of land is lost to crop production each year in Pakistan (Yasin *et al*., 1998)

Soil salinity not only delayed but also reduced flowering and yield of crop plants (Ahmed *et a.,* 2005). It may affect pollination and thus decreased seed set and grain yield (Mass, 1986). Reduction in yield under salinity has been reported in many crops viz: wheat, barley, bean, rice and cotton (Keating and Fisher, 1985). Maas *et al*. (1986) exposed two sorghum cultivars to salinity and determined the reduction in dry matter and grain yield. Saline irrigation water applied to soybean significantly reduced the growth and yield, when grown on hill (Beecher, 1994). Singh *et al*. (1989) reported that four *Vigna radiata* cultivars on plots salinized with 2,4, and 6 dS m^{-1} gave average seed yields of 906, 504, and 370 Kg / ha, respectively.

Mungbean is an important legume of dry land agriculture. Legumes are being used in annual crop rotations on an increasingly large area of heavy clay soils in many regions of Pakistan. These soils frequently have moderate to high levels of salts, predominantly sodium chloride. Since mungbean production (455 Kg/ha) in Pakistan is very low as compared to other countries of the world (Anonymous, 2001). This is due to the reason that major part of mungbean growing areas is salt affected. In order to make effective utilization of salt affect soils, it is important to select such mungbean genotypes, which may endure salt stress and produce substantial yield under saline environment.

MATERIALS AND METHODS

The experiment was a pot trial, which was carried out in the wire house of Botanical Garden, University of Agriculture, Faisalabad under natural conditions. The seeds of two mungbean genotypes 245/7 and 241/11 collected from Khushab (Salt Range) while three advanced genotypes, viz., NM-51, NM-92 and 6601 were obtained from Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad. The genotypes were selected for tests and trails base upon contrasting seed characteristics. The plants were raised in earthen pots 30 cm in diameter lined with polythene bags, containing 10 kg of sun dried, homogeneously sandy loam soil and three plants were maintained per pot after thinning. The pots were placed in a wire house in complete randomization. The physico-chemical characteristics of soil were ; organic matter 1.2% ; cation exchange capacity 11.3 meq l^{-1} ; pH 7.4 ; ECe 0.8 dS m^{-1} ; sodium absorption ratio 0.05 meq l^{-1} ; Na^+ 2.35 meq l^{-1} ; Cl^- 5.83 meq l^{-1} ; SO_4^{2-} 1.49 meq l^{-1} and Ca + Mg 14.5 meq l^{-1} . The average temperature during the experiment was between 33 ^{0}C $\pm$ 4 to 40 ^{0}C $\pm$ 3 , relative humidity between 27% $\pm$ 4 to 35% $\pm$ 8 and rainfall ranged from 62 to 84 mm.

The salinity was imposed in pots, at different growth stages i.e., vegetative, flowering and seed filling stages. Tap water was used for irrigation throughout the growth period as and when needed. The EC of the tap water was also measured by EC meter, which was ranging from 0.3 to 0.5 dS m^{-1} during the experiment. The data for yield and yield components were recorded at the maturity of crop. Data collected were analyzed by analysis of variance technique.

RESULTS AND DISCUSSION

The statistical analysis for the pod characteristics of economic yield of mungbean i.e., number of pod per plant, average pod length, fresh and dry weight of pod per plant, indicated highly significant ($P<0.01$) differences among the genotypes with increased salinity and interactions of these factors were also highly significant ($P<0.01$) except the interaction for dry weight of one pod (Table 1). The increasing levels of NaCl applied salinity decreased all the pod characteristics of economic yield taken at maturity in all the genotypes indicate distinct behavior for these economic yield parameters which was greatest in NM-92, while it was lowest in 241/11.

The analysis of variance for seed characteristics of economic yield i.e., number of seed per plant, 100 seed weight and seed yield per plant, indicated statistically highly significant ($P<0.01$) except the number of seed per pod which was non-significant ($P>0.05$). The applied NaCl salinity decreased all the seed characteristics of economic yield in all genotypes at maturity under present studies (Table 1). However, the genotype indicated peculiar behavior for all the seed characteristics of economic yield parameters which was the maximum in NM-92, while it was virtually nil in 241/11, as no pod formation was observed in this accession at the highest level of NaCl salinity.

Table 1. Changes in some yield assay of mungbean genotypes under NaCl salinity at maturity.

Genotype	Salt Levels (dS/m)	Pod Characteristics						Seed Characteristics			
		No. pod / plant	Av.pod length (cm)	Fr. Wt of one pod (g)	Dry Wt. of one pod(g)	Tot.Fr. Wt.pods/ plant (g)	Tot.Dry Wt.pods /plant (g)	No.of Seed/ pod	No.of Seed/ plant	100 Seed Wt.(g)	Seed yield/ plant (g)
245/7	Control	5	6.1	0.39	0.29	2.09	1.57	8	41	4.12	3.15
	4	4	4.8	0.27	0.19	1.17	0.81	6	28	3.15	2.49
	8	3	3.7	0.16	0.12	0.55	0.38	4	15	2.50	1.27
	12	2	2.1	0.11	0.08	0.22	0.13	3	06	1.36	0.99
241/11	Control	7	4.2	0.35	0.22	2.56	1.58	8	44	3.10	2.67
	4	5	3.7	0.23	0.20	1.23	1.06	8	43	2.47	2.15
	8	2	2.9	0.12	0.08	0.20	0.13	1	3	1.22	1.01
	12	0	0.0	0.00	0.00	0.00	0.00	0	0	0.00	0.00
NM-51	Control	9	5.4	0.33	0.29	2.88	2.56	9	75	4.88	4.92
	4	6	4.9	0.27	0.20	1.42	1.08	7	39	4.68	3.39
	8	3	3.9	0.21	0.16	0.65	0.52	6	21	3.96	1.79
	12	2	2.4	0.11	0.09	0.19	0.14	4	7	3.09	1.11
NM-92	Control	9	5.5	0.37	0.42	3.35	2.45	9	81	4.95	5.31
	4	6	4.9	0.27	0.13	1.51	1.13	6	50	4.76	4.19
	8	3	3.4	0.21	0.15	0.55	0.41	4	34	4.10	2.05
	12	2	3.1	0.19	0.10	0.26	0.15	2	13	3.29	1.41
6601	Control	7	5.6	0.39	0.29	2.85	2.11	9	64	4.87	3.85
	4	5	4.8	0.33	0.23	1.73	1.09	6	34	4.47	3.15
	8	2	3.9	0.15	0.12	0.25	0.50	3	5	2.75	1.52
	12	1	2.0	0.07	0.05	0.07	0.05	2	2	2.47	1.09
Summary of significance of variance sources											
Genotypes (G)	4	**	**	**	n.s.	**	**	n.s.	**	**	**
Salinity (S)	3	**	**	**	**	**	**	**	**	**	**
G x S	12	**	**	**	n.s.	**	**	n.s.	**	**	**

Significant at P∠0.01 n.s., non-significant

The economic yield of crops is adversely affected under salt stress. One of the attributes for reduced yield may be a reduction in pod and seed production by the plant. Gill (1999) reported similar result of effect of soil salinity on yield in barley. Furthermore, mungbean under present investigation differed widely in yield and its component attributes under normal as well as under saline conditions. This may ultimately lead to reduce seed yield under salinity and consequent lower economic yield.

Most of the glycophytes experience a depression in overall yield and yield components when exposed to relatively elevated levels of Na^+ and Cl^- (Curtis and Lauchli, 1986). The NaCl associated decreased Ψs was known to rate the growth of aerial parts i.e., root, shoot and leaves either increased (Dukeck *et al*., 1983) or decreased (Ashraf and Rasul, 1988). In current experiment a significant reduction in the aerial part of plant may also be consequent to the decreased dry matter production and economic yield (Table 2).

Table 2. Some morpho-reproductive characters of mungbean genotypes at 8dS m^{-1} and 12 dS m^{-1} NaCl salinity.

Mropho-reprodutive characters	**Genotypes** 245/7		241/11		NM-51		NM-92		6601	
	8dS/m	12d S/m	8dS/m	12d S/m	8dS/m	12d S/m	8dS/m	12d S/m	8dS/m	12d S/m
No. of living flowers	β	γ	β	γ	α	β	α	α	α	α
No. of senescent flowers	γ	α	β	α	β	α	γ	β	β	α
No. of dead flowers	α	α	α	α	β	α	β	β	β	α
Colour of living flowers	Y	LY	DY	LY	Y	LY	Y	LY	Y	LY
Colour of dead flowers	LBi	LBi	LBi	Bi	LBi	DBi	Bi	DBi	Bi	Bi
Immature pod colour	GBr	LBr	LBr	-	GBr	Br	GBr	Br	GBr	LBr
Mature pod colour	DBr	BiBr	DBr	-	DBr	DBr	DBr	BiBr	DBr	DBr
Dead pod colour	Bi	Bi	BiBr	-	BiBr	Bi	Bi	Bi	Bi	Bi
Seed colour	DG	Bi	LG	-	LG	DG	LG	DG	DG	DG
Seed surface	SR	R	S	-	S	S	S	SR	SR	R
Seed size	M	Sa	Sa	-	La	M	La	La	La	M

For flower number Large:α ; Medium:β ; Small:γ
For flower & pod colour: Black:Bi ; Brown:Br ; Dark:D ; Green:G ; Light:L ; Yellow:Y
Seed size: Large: La ; Medium: M ; Small: Sa
Seed surface: Smooth:S ; Rough:R ; Smooth Rough:SR

Another drastic reason for the reduction of yield and its component rated under salt stress condition, may be due to low production, expansion, senescence and physiologically less active green foliage (Rawson *et al*., 1988; Schactman and Munns, 1992; Kumar *et al*., 1994, Wahid *et al*., 1997), thus reduced photosynthetic rate might be a supplementary effect (Seemann and Critchley, 1985). It is concluded in present investigation that morpho-physiological characteristics may also play a crucial role directly or indirectly in the reduction of efficiency per day of plant as well as effective filling period duration of seed lead to decrease the economic yield of mungbean. Therefore, lengthening the time required for seed filling under salt stress pushed the plants at seed filling and maturity to high temperature and water stress due to the summer (Gill, 1999). The effect of both salt and water stress might lead to shriveled seeds and consequent lower yield. Thus, it may be also concluded that reduced yield of mungbean under salt stress is due to reduced efficiency per day of plant to filled the developing seeds, which may lead to reduced the number of seeds per pod / or plant and dry matter yield of individual seed. Delayed maturity due to salt stress pushes the plant also to desiccation stress causing shriveled seeds.

REFERENCES

Anonymous (2001). *Agriculture Statistics of Pakistan.* Ministry of Food Agriculture and Livestock. Government of Pakistan, Islamabad.

Ashraf, M. and E. Rasul (1988). Salt tolerance of mungbean [*Vigna radiata* (L.) Wilczek] at two growth stages. *Plant Soil.*, 110: 63-67.

Beecher, H. G. (1994). Effect of saline irrigation water on soybean yield and soil salinity in the Murrumbidgee valley. *Aust. J. Exp. Agric.*, 34 : 85-91.

Curtis, P. S. and A. Läuchli (1986). Role of leaf area development and photosynthetic capacity in determining growth of Kenaf under moderate salt stress. *Aust.J.Plant Physiol*., 13: 553-565.

Dudeck, A. E., S. Singh., C.E., Giodano., T. A. Nell, and D. B. McConnell (1983). Effect of sodium chloride on *Cynodon* turf grasses. *Agron. J.*, 75: 927-930.

Gill, K. S. (1999). Effect of soil salinity on grain filling and grain development in barley. *Biologia Plant.*, 21: 241-244.

Keating, B. A. and J. M. Fisher (1985). Comparative tolerance of tropical grain legumes to salinity. *Aust. J. Agric. Res*., 36: 373-383.

Kumar, S, K. M., Naidu, and H. L. Sehtia (1994).Causes of growth reduction in elongating and expanding leaf tissue of sugarcane under saline conditions. *Aust. J.Plant Physiol*., 21: 79-83.

Maas, E. V. (1986). Salt tolerance of plants. *Appl. Agric. Res*., 1: 12-26.

Maas, E. V., J. A. Poss and G. J. Hoffman (1986). Salinity sensitivity of sorghum at three growth stages. *Irrig. Sci.*, 7: 1-11.

Rawson, H. M., R. A. Richards and R. Munns (1988). An examination of selection criteria for salt tolerance in wheat, barley and triticale genotypes. *Aust. J. Agric. Res*., 39: 759-772.

Sarin, M.N., Y.C. Joshi and K.S. Gill (1975). Salt tolerance of wheat and barley varieties .*Proc. Symposium. New Developments in the field of Salt Affected Soils*. I.S.S.S Carro. Pp 647-652.

Schachtman, D. P. and R. Munns (1992). Sodium accumulation in leaves of *Triticum* species that differ in salt tolerance. *Aust. J. Plant Physiol*., 19: 331-340.

Seemann, J. R. and C. Critchley (1985). Effects of salt stress on the growth, ion contents, stomatal behaviour and photosynthetic capacity of a salt sensitive species. *Phaseolus vulgaris* L. *Planta*, 164: 66-69.

Singh, H. B., P. S. Mali, H. C. Sharma and H. Singh (1989) Relative performance of mungbean (*Vigna radiata L.* Wilczek) cultivars under varying levels of soil salinity. *Haryana J. Agron*., 5: 171-173.

Wahid, A., R. Rao. and E. Rasul (1997). Identification of salt tolerance traits in sugarcane lines. *Field Crop. Res*., 54: 9-17.

Yasin, M., R. Zada, and B.H.Niazi (1998). Effectiveness of chemical and biotic methods for reclamation of saline-sodic soil. *Pak. J. Soil Sci.* 15: 179-182

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