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# EFFECT OF SOIL SALINITY ON THE YIELD AND YIELD COMPONENTS OF MUNGBEAN

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**Abstract**

Experiment was conducted with 5 mungbean accessions/genotypes with the aim of ascertaining the effect 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 accessions/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.

## Introduction

Soil salinity not only delays but also reduces flowering and yield of crop plants (Gill, 1979). It may affect pollination and thus decrease 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 & 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 in plots salinized with 2,4, and 6 dS $m^{-1}$ gave average seed yields of 906, 504, and 370 kg / ha, respectively.

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 place 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). 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. Mungbean production (455 kg/ha) in Pakistan is very low as compared to other countries of the world (Anon., 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 affected soils, it is important to select such mungbean genotypes, which may endure salt stress and produce substantial yield under saline environment.

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## Materials and Methods

The experiment was a pot trial carried out in the wire house of Botanical Garden, University of Agriculture, Faisalabad under natural conditions. The seeds of 2 mungbean accessions 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 accessions / genotypes were selected for then trails showed contrasting seed characteristics. The plants were raised in earthen pots 30 cm in diameter lined with polythene bags, containing 10 kg of sun dried, homogeneous sandy loam soil and three plants were maintained per pot after thinning. The pots were randomized placed in a wire house. The physico-chemical characteristics of soil were; organic matter 1.2%; cation exchange capacity 11.3 meq $l^{-1}$; pH 7.4; EC 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°C ± 4 to 40°C ± 3, relative humidity between 27% ± 4 to 35% ± 8 and rainfall ranged from 62 to 84 mm.

Salt solution with 4, 8 and 12 dS/m EC were added to soil 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 statistically analyzed (Steel & Torrie, 1960).

## Results

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 accessions / 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 decreased all the pod characteristics of economic yield taken at maturity in all the accessions/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 results ($p<0.01$) except for the number of seed per pod which was non-significant ($p>0.05$). The increasing salinity, decreased all the seed characteristics of economic yield in all accessions / genotypes at maturity under present studies (Table 1). However, the accession/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. Moreover, some changes occurred in morpho-reproductive characters of 5 mungbean genotypes at 8 dS $m^{-1}$ and 12 dS $m^{-1}$ levels of NaCl salinity at maturity (Table 2).

**Table 1. Yield parameter of mungbean genotypes under NaCl salinity at maturity.**

| Genotype | Salt levels (dS/m) | Pod characteristics | | | | | | Seed characteristics | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. of pod/ plant | Av. pod length (cm) | Fr. Wt of one pod (g) | Dry wt. of one pod (g) | Tot. Fr. Wt. of pods/ Plant (g) | Tot. dry wt. of 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

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

| Mropho-reproductive 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 High: α; Medium: β; Low: 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

## Discussion

The economic yield of crops is adversely affected under salt stress (Sarin *et al*., 1975). One of the attributes for reduced yield may be a reduction in pod and seed production by the plant. Gill (1979) 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 & Lauchli, 1986). NaCl the growth of root, shoot and leaves either increased (Dudeck *et al*., 1983) or decrease (Ashraf & Rasul, 1988). In current experiment a significant reduction in the growth of aerial part of plant may also be consequent to the decreased dry matter production and economic yield.

Reduction of yield and its component rated under salt stress condition may also be attributed to low production, expansion, senescence and physiologically less active green foliage (Rawson *et al*., 1988; Schactman & Munns, 1992; Kumar *et al*., 1994; Wahid *et al*., 1997), thus reduced photosynthetic rate might be a supplementary effect (Seemann & Critchley, 1985). The morhpho-physiological characteristics also play a crucial role directly or indirectly in the reduction of efficiency per day of plant as well as effective filling period of seed and may lead to decreased the yield of crop. According to Gill (1979) lengthening the time required for seed filling under salt stress pushe the plants at seed filling and maturity to high temperature and water stress due to the summer. The effect of both salt and water stress might lead to shriveled seeds and consequent lower yield. Thus, it may be concluded that reduced yield under salt stress may be due to reduced efficiency per day of plant to fill the developing seeds, which may lead to reduced 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.

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