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GROWTH AND NODULATION OF MUNGBEAN (*VIGNA RADIATA* [L.] WILCZEK) AS AFFECTED BY SODIUM CHLORIDE

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Abstract: The growth and nodulation of *Vigna radiata* were compared at four levels (0-0.3 % NaCl added to garden soil) of salinity in pot experiments. Dry mass of plants, 7 and 11 weeks after the commencement of salinity treatment, decreased with increasing salinity levels. Number of nodules and fresh weight of nodules per plant decreased with increasing salinity. As the number of nodules decreased, average size of the nodules increased with increasing salinity levels. Reproductive growth was also adversely affected by the salinity as the number and fresh weight of pods per plant decreased with increasing salinity.

Keywords: Biological nitrogen fixation, mung bean, nodulation, plant growth, salinity, *Vigna radiata*.

INTRODUCTION

Nitrogen is the most abundant element in our atmosphere (78.08 % V/V) but plants are unable to use it as such. It has to be transformed either chemically or biologically into ammonium form before being assimilated by plants. Industrial fixation of nitrogen resulting in the production of chemical fertilizers by Haber-Bosch process has greatly helped in increasing the crop production. However, the rising costs of nitrogenous fertilizers and ecological concern about potential environmental hazards of these fertilizers suggest a need for enhancement and extension of biological nitrogen fixation [Sprent and Sprent 1990].

Legumes are capable of fixing atmospheric nitrogen through a symbiotic association with soil bacteria called *Rhizobium*. These bacteria form nodules on the roots of leguminous plants. Symbiotic nitrogen fixation is the result of a delicate balance between a higher plant and specific bacteria. It is important to understand properly the optimum conditions for this fixation in order to provide full benefits to the plant [Stacy *et al.* 1992, Walsh 1995].

Saline soils are common in regions of arid or semi-arid climate where transport of soluble salts to the ocean does not occur because of low rainfall [Eaglesham and Ayanaba 1984]. Saline conditions may affect the legume-*Rhizobium* symbiosis by reducing the survival of rhizobia, inhibiting the infection process, affecting nodule development and function, or reducing plant growth [Singleton and Bohlool 1984]. Considering the proportion of soils in the world that are saline, remarkably little effort has been expended on examining the effect of salinity on nitrogen fixation [Sprent and Sprent 1990]. The present study was, therefore, conducted to study the effects of salinity on growth and nodulation of an oriental legume crop, *Vigna radiata.*

MATERIALS AND METHODS

Seeds of Mung bean (*Vigna radiata* [L.] Wilczek) cultivar NM-51 (obtained from NIAB, Faisalabad) were sown in plastic pots containing garden soil (EC_e =1.07 dS m^{-1} at 25 ºC). Two weeks after sowing, a range of salinity treatments (0, 0.1, 0.2 and 0.3 % NaCl added to the soil, wt./wt.) was applied to the plants. For this purpose, the salt was first dissolved in 1 L water that was sufficient to soak the soil in each pot. The pots were watered as and when required and care was taken not to leach the salt by excess watering. There were nine replicates for each treatment and the experiment was arranged in a completely randomized design. Pots were harvested 7 and 11 weeks after the commencement of salinity treatment when the mung bean plants were at the beginning of pod growth and middle of pod growth stages, respectively. At the first harvest, electrical conductivity (EC_e) of soil samples from the root zone was also measured using a conductivity meter (CM-30EF). The electrical conductivities (EC_e) at 25 ºC for the soil amended with 0, 0.1, 0.2 and 0.3 % NaCl were 1.07, 1.26, 1.80 and 2.41 dS m^{-1}, respectively.

RESULTS AND DISCUSSION

The growth response of *Vigna radiata* to salinity at the two harvests showed a gradual decrease in plant dry mass with increasing NaCl levels (Fig. 1). At first harvest, the dry mass of plants was decreased to 66, 45 and 15 % of the control by 0.1, 0.2 and 0.3 % NaCl added to soil, respectively. At second harvest, the plant dry mass decreased to 84, 66 and 0 % of the control by 0.1, 0.2 and 0.3 % added NaCl, respectively. The reproductive growth of Mung bean was also affected by salinity as the number of pods per plant and fresh weight of pods per plant substantially decreased with increasing salinity levels (Table 1). Eleven weeks after the commencement of salinity treatment, pod number per plant decreased to 35 and 32 % of the control, whereas pod fresh mass per plant decreased to 71 and 44 % of the control at 0.1 and 0.2 % added NaCl levels, respectively. At the next higher level of added NaCl (i.e., 0.3%), pod formation was completely inhibited. These results are similar to other reports [Yousef and Sprent 1983, Mirza and Tariq 1993a,b, Elsheikh and Wood 1995] that have shown inhibitory effect of salinity on plant growth. Present results, however, do not agree to Greenway and Munns [1980] and Ng [1987] who noticed increased growth at low salinity levels. This may be due to variable response of different plant species to salinity.

Root nodulation was adversely affected by the salinity treatments (Table 2). At each harvest, the nodule number per plant and nodule fresh weight per plant decreased with increasing NaCl levels. At the second harvest, the number of nodules per plant decreased to 54 and 36 % of the control by 0.1 and 0.2 % added NaCl, respectively. The next higher level of added NaCl (i.e., 0.3%) completely inhibited nodule formation. In contrast, the nodule size generally increased with increasing salinity levels at each harvest.

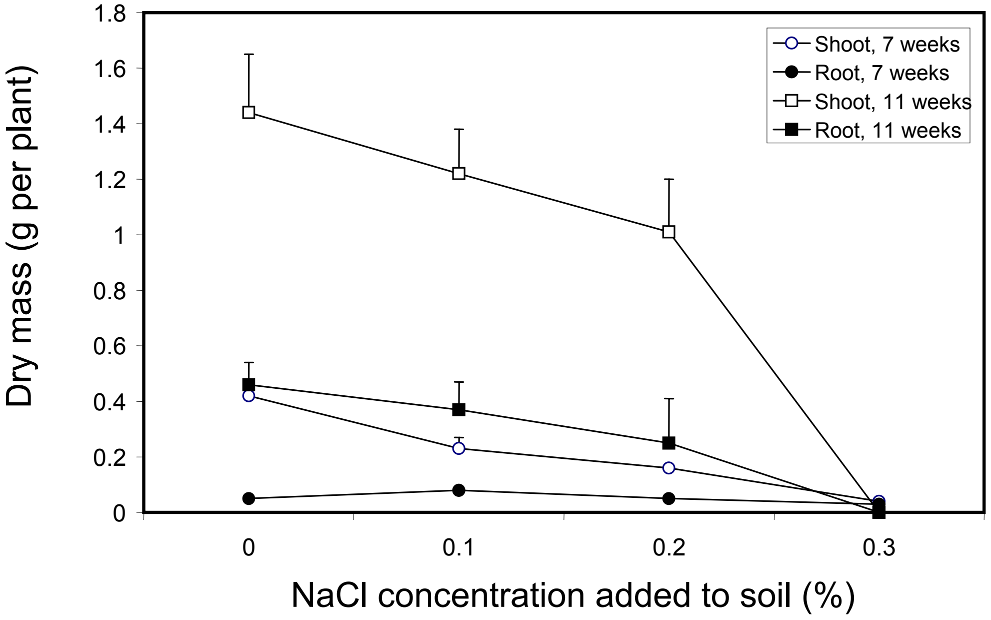

Fig. 1: Effect of NaCl concentration on shoot and root dry mass of *Vigna radiata*, 7 and 11 weeks after the commencement of salinity treatment.

Table 1: Effect of NaCl concentration on pod number and pod fresh mass of *Vigna radiata,* 11 weeks after the commencement of salinity treatment. Each value represents mean of 9 replicates ± SEM.

NaCl conc. added to soil (%)	EC_e ($dS\ m^{-1}$)	Pod number $plant^{-1}$	Pod fresh mass ($g\ plant^{-1}$)
0.0	1.07	1.89 ± 0.45	0.41 ± 0.08
0.1	1.26	0.67 ± 0.33*	0.29 ± 0.12
0.2	1.80	0.60 ± 0.40	0.18 ± 0.14
0.3	2.41	0.00	0.00

* Significantly different to the control at $P < 0.05$.

The present results can be compared with some other reports. Elsheikh and Wood [1995] observed that growth and nodulation of soybean was adversely affected by salinity and that nodulation was more sensitive than plant growth to salinity. Yousef and Sprent [1983] grew *Vicia faba* under salt stress and found that the number of nodules per plant was depressed but this was partially compensated by producing larger nodules. In previous studies, Mirza and Tariq [1992] reported that salinity decreased the number of nodules per plant but increased the size of nodules in *Sesbania sesbane.* Mirza and Tariq [1993a, b] also observed adverse effects of salinity on nodulation of *Cicer arietinum* and *Trifolium alexandrinum*. Present results are similar to those of Yousef and Sprent [1983] and Mirza and Tariq [1992] who observed that the adverse effect of salinity on nodule number was partially compensated by an increase in nodule size.

Table 2: Effect of NaCl concentration on nodule number, nodule fresh mass and nodule size of *Vigna radiata,* 7 and 11 weeks after the commencement of salinity treatment. Each value represents mean of 9 plants ± SEM.

		7 weeks			11 weeks		
NaCl conc. added to soil (%)	EC_e ($dS\ m^{-1}$)	Nodule number $plant^{-1}$	Nodule fresh mass ($g\ plant^{-1}$)	Nodule size (mm)	Nodule number $plant^{-1}$	Nodule fresh mass ($g\ plant^{-1}$)	Nodule size (mm)
0	1.07	0.55 ± 0.22	0.03 ± 0.01	1.38 ± 0.30	3.70 ± 0.47	0.13 ± 0.02	2.72 ± 0.30
0.1	1.26	0.44 ± 0.24	0.02 ± 0.01	1.25 ± 0.25	2.00 ± 0.6	0.10 ± 0.05	2.90 ± 0.42
0.2	1.80	0.28 ± 0.19	0.02 ± 0.01	1.60 ± 0.40	1.33 ± 0.54*	0.08 ± 0.04	3.66 ± 0.52
0.3	2.41	0.11 ± 0.01*	0.01 ± 0.00*	2.00 ± 0.36	0.00	0.00	0.00

* Significantly different to the control at $P < 0.05$.

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