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GROWTH PERFORMANCE OF *VICIA SATIVA* L. UNDER SALINE CONDITIONS

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Abstract

Vicia sativa L., an annual winter growing leguminous plant, is a valuable source of protein and minerals for cattle. It was tested for salinity tolerance in laboratory and pot experiments using three levels of salinity viz., 5, 10, and 15dSm^{-1}. It was observed that the germination and seedling growth declined at 10 and 15dSm^{-1} level of applied salt. The survival of seedling was affected severely in high salt concentration. Similarly various growth parameters including degree of branching, length of shoots and roots, fresh weight of shoots and roots declined at 10, and 15dSm^{-1} salinity levels. The present findings suggest that *Vicia sativa* can tolerate moderate levels of salinity and might be cultivated on marginal saline habitat as a source of fodder and nutrients to the soil.

Introduction

About 7% of the world's total land area including 26% of land area of Pakistan is affected by salt in semi-arid to arid regions of the world (Alam, 2002; Munns, 2006). Salinity is one of the most important abiotic stresses faced by the human kind that adversely affects the metabolism and gene expression in plants (Mahadavi & Sanavy, 2007). Salinity interferes with water and nutrient uptake, physic-chemical properties of soil, thus reducing productivity (Munns *et al*., 2002; Munns & James, 2003; Munns, 2006; Ashraf & Harris, 2004; Mahajan & Tuteja, 2005; Chookhampaeng *et al*., 2007; Turan *et a*l., 2007). The identification of species capable of growing on saline habitats is a good way of using such unproductive lands (Munz & James, 2003; Bischoff & Werner, 2004, Akhtar & Hussain, 2008).

Vicia sativa L., (Tare or Vetch), a nitrogen fixing leguminous plant, is a valuable source of protein and minerals for fattening cattle. Common Vetch historically has also been part of the human diet in ancient civilizations. Hamada & El-Enany (1994) reported reduced growth of *Vicia faba* in pot grown soil salinity. Many legumes and forage plants exhibit reduced growth under saline condition (Orak & Ateş, 2005; Tamer *et al*., 2006; Mahadavi & Sanavy, 2007; Turan *et al*., 2007). Reclaiming salt affected land is always costly and time consuming. The other alternative is to use such unproductive soils as such for forage production that will not only meet the demands of forage for the cattle but also provide food for the expanding population. For this purpose screening of suitable plants is needed. The present attempt is a step forward in this direction to test the tolerance of *Vicia sativa* L for its suitability to saline habitats.

Materials and Methods

Germination and seedling growth studies in laboratory: Certified seeds of *Vicia sativa* L. were obtained from Pakistan Forest Institute, Peshawar. Viability of the seeds was tested by tetrazolium test. The glassware was thoroughly washed with tap water followed by rinsing with distilled water and sterilization at 170^{o}C for 4 hours. Ten viable seeds of *Vicia sativa* were placed at equal distances in 7 cm Petri dishes on twice folded Whatman No. 1 filter paper seed beds. Each treatment was replicated 10 times. NaCl concentration of 5.0, 10.0 and 15.0 dSm^{-1} was applied while control had no salt. The Petri dishes were incubated at 25±1°C. Germination percentage, radical and plumule growth was recorded after 96 hours. Fresh weights of the 20 randomly selected seedlings from each of the treatments were determined. Seedlings were dried at 65±1°C for 72 hours and dry weights were determined. The moisture contents of the seedlings were determined on oven dry bases.

Pot experiment: Seeds of *Vicia sativa* were sown in October in 20x12 cm pots containing 5 Kg loamy soil, which was lined with polyethylene bags to avoid salt leaching. There were five replicates for each treatment. The soil used had 8.75% $CaCO_3$, 2.6% organic matter, 0.12% nitrogen, 20.9 ppm phosphorus, 413.5 ppm potassium, 1.2 µg gm^{-1} copper, 2.2 µg gm^{-1} zinc, 3.1 µg gm^{-1} iron, 4.0 µg gm^{-1} manganese, 200 µg gm^{-1} calcium, 305 µg gm^{-1} potassium, 216 µg gm^{-1} sodium, 7.7 pH level, 0.21dSm^{-1} EC, 0.067% total soluble salts, 27.3% clay, 46.0% silt and 26.7% sand. Three levels of salinity i.e., 5.0, 10.0, 15.0 dSm^{-1}were developed by adding appropriate amount of NaCl to each pot. Control had no salt.

After 25 days, when germination was completed, thinning was done leaving 5 uniform equidistant and healthy seedlings. The survival percentage, height, number of branches and other growth parameters were recorded in the last week of March. Roots were carefully removed from soil and their lengths, fresh and dry weights, and moisture contents were determined as before. The results were subjected to software SPSS and ANOVA (Steel & Torie, 1980).

Results and Discussion

Germination is the most critical stage in seedling establishment. In the lab experiment it was seen that the %germination, radical and plumule growth was drastically reduced by various levels of salinization especially at15 dSm^{-1} (Table 1), where the reduction was by 5 times in germination, 11 times in radical growth and 32 times in plumule growth. The findings agree with those of Zia & Khan (2002), Hameed *et al*., (2006), Akhtar & Hussain (2008) and Mahdavi & Sanavy (2007), who also reported reduced germination and seedling growth of other plants under saline condition. The findings are also supported by Jain *et al*., (1991), who concluded that decreased germination percentage in *Trigonella foenum-graecum* was due to the increased salt concentrations**.** Zia & Khan (2004) showed that exposure of seeds to salinity and temperature regimes had little effect on viability of seeds. The reduced seedling growth in the present study is supported by Mahadavi & Sanavy (2007), who also reported decreased seedling growth of *Lathyrus* due to salinity. Even coastal halophytes exhibited reduced germination under high salt stress (Zia & Khan, 2002; Hameed *et al*., 2006). Waheed *et al*., (2006) observed that although the rate of germination in *Cajanus* was affected but the final germination remained unaffected.

The seedling biomass of *Vicia sativa* was also low due to applied salinity (Table 1). Tamer *et al*., (2006) and Akhtar & Hussain (2008) reported poor seedling biomass of forage plants under saline condition. The moisture contents almost remained unaffected in all the treatments. The findings agree with those of Hameed *et al*., (2006) who also reported decrease in fresh and dry weights of shoots and roots of *Cajanus* under saline condition.

Table 1. Effects of various levels of NaCl (dSm^{-1}) salinization on the germination (%) and seedling growth of *Vicia sativa* incubated at 25°C. Each value is a mean of 5 replicates with 10 seeds each. Fresh and dry weight and moisture contents are means of 25 randomly selected seedlings from each treatment.

Parameters	Salinity levels (dSm^{-1})			
	Control	5	10	15
Germination %	32	30	16	6
Radical length (mm)	11	6	3	1
Plumule length (mm)	16	9	2	0.43
Fresh weight (gm)	1.0472	1.0370	0.0721	0.0290
Dry weight (gm)	0.091	0.0750	0.0100	0.0050
Moisture contents (%)	98.95	98.96	99.93	99.99

Table 2. Effect of various levels of NaCl (dSm^{-1}) salinization on plant survival, number of branches, lengths, fresh and dry weights of shoots of *Vicia sativa*. Each value is mean of 5 plants.

Parameter	Control	Salinity levels dSm^{-1}		
		5	10	15
Survival %	100	84	84	70
Average no. of branches	12	12	9.60	10
Average length (cm)	25.8	32.6	23.4	26.5
Fresh weight (gm)	10.18	11.94	10.50	8.79
Dry weight (gm)	3.26	4.03	2.47	2.73

The laboratory experiment was extended to pot experiment in the field. It was observed that the survival percentage of seedling decreased with the increasing salinity level (Table 2). However, ANOVA (Table 3) value of P=0.712 showed insignificant differences among the different levels of NaCl. At 15dSm^{-1} the survival percentage was 70%. Hussain *et al*., (1993) reported that *Cicer arietinum* was moderately tolerant to salinity at germination and seedling stages. The degree of branching decreased with the increasing level of salinity (Table 3). However, ANOVA value of P=0.914 showed insignificant (5% level) differences among the different levels (Table 3). The mean of NaCl at 5 dSm^{-1} and control is 12.00, which is higher than the other levels (10 dSm^{-1}, 15 dSm^{-1}). Similarly, Morales *et al*., (1993) and Boem *et al*., (1994) reported decreased yield, branching and siliqua/plant and yield in various *Brassica* species. The average number of branches and average lengths of *Vicia sativa* declined under salinization. The present findings also agree with those of Turan *et al*., (2007) who reported reduced growth of lentil under increasing soil salinity.

b. Effect on fresh and dry weight of shoots: Fresh and dry weight of shoots also decreased with increasing salinity (Table 2) but ANOVA value of P=0.238 indicated insignificant differences among the different levels of NaCl on fresh weight (Table 3). Tamer *et al*., (2006) stated that forage production including *Vicia* decreased under salinity stress and this also strengthens the present findings. The present results are also in line with those of Hameed *et al*., (2006) who reported decline in fresh and dry weights of shoots under salinity stress.

Table 3. ANOVA for plant survival, number of branches, shoot length, fresh and dry weights of shoots.

	Sum of squares	df	Mean square	F	Significance
a. Average plant survival					
Between groups	2.15	3	0.717	0.462	0.712
With in groups	24.80	16	1.55		
Total	26.95	19			
b. No. of branches					
Between groups	24.60	3	8.20	0.172	0.914
With in groups	763.20	16	47.70		
Total	787.80	19			
c. Shoot length					
Between groups	228.14	3	76.05	2.225	0.125
With in groups	546.80	16	34.18		
Total	774.94	19			
d. Shoot fresh weight					
Between groups	25.10	3	8.365	1.56	0.238
With in groups	85.80	16	5.362		
Total	110.89	19			
e. Shoot dry weight					
Between groups	7.01	3	2.338	2.497	0.097
With in groups	14.98	16	0.936		
Total	21.99	19			

Table 4. Effect of various levels of salinization on the growth performance of roots of *Vicia sativa*.

Parameter	Control	Salinity dSm^{-1}		
		5	10	15
Length of roots (cm)	21.6	28.0	22.6	19.8
Fresh weight of roots (gms)	1.32	0.50	0.43	0.31
Dry weight of roots (gms)	0.07	0.06	0.17	0.13

c. Effect on root development: The length, fresh and dry weights of roots also declined with increasing level of salinity (Table 4) with ANOVA value of P=0.000 indicating highly significant differences among the different levels of NaCl on root length (Table 5). The ANOVA value of P=0.002 suggested that there are significant differences among the different levels of NaCl on root dry weight (Table 5). The tolerance mechanism in plants is very complex process as reported by Udvardi *et al.*, (2007) who stated that in *Medicago truncatula* a large proportion of the genome are involved in high-salinity stress responses. Salinity may reduce chlorophyll, photosynthesis or may bring other abnormal changes in the functioning of plant body that ultimately reduces the overall growth and productivity. The present study showed that *Vicia sativa* is tolerant to low salinity levels that can be grown as fodder on marginal saline land. Study made in the laboratory although may provide some information but it may not infer the actual germination and growth responses under field condition (Hameed *et al.*, 2006). Therefore further study is required to reach to some meaningful conclusions.

Table 5. ANOVA for the length, fresh and dry weights of roots.

	Sum of squares	df	Mean square	F	Significance
a. Root length					
Between groups	739.75	3	246.58	32.04	0.000
With in groups	123.20	16	7.70		
Total	862.95	19			
b. Root fresh weight					
Between groups	3.23	3	1.078	18.301	0.000
With in groups	0.94	16	5.89 E-02		
Total	4.17	19			
c. Root dry weight					
Between groups	4.41 E-02	3	1.47E02	7.76	0.002
With in groups	3.03E-02	16	1.895E03		
Total	7.44E-02	19			

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