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Tolerance of Five Azarbaijan Alfalfa Ecotypes to Salinity

Hassan Monirifar

East Azarbaijan Research Center for Agriculture and Natural Resources, Tabriz, Iran

monirifar@yahoo.com

ABSTRACT

Breeding for salt tolerance in crop species, if possible, is an economical approach to overcoming the problem of soil salinity. However, the availability of appropriate genetic variation at the intraspecific level is a prerequisite for successful progress under selection. Genetic variation for NaCl tolerance at the seedling and mature plant stage was assessed in five Azarbaijan native alfalfa cultivars. A completely randomized design (CRD) with 5×4 factorial arrangements and three replication were used. Syah-Roud, Gara-Yonjeh, Hasht-Roud, Khor-Khor and Bash-Kand cultivars were used as a first factor and second were three levels of salt and a control. Salt levels were 3.07, 10, 20 and 30 mm mohs (Ec), which were achieved by adding 0, 1.062, 2.431 and 5.071 g kg^{-1} NaCl to pots soil. Total dry weight, leaves and shoot dry weight, height, number of leaves and leaf/stem ratio (TDW, LDW, SDW, H and NL) were measured. The results indicated that the response was significantly different among cultivars as well as NaCl levels. The NaCl effect was significant in reducing all measured traits of all five ecotypes. Bash-Kand had the highest; Syah-Roud and Gara-Yonjeh cultivars had the lowest yield reduction percentage, respectively. In general, Syah-Roud and Gara-Yonjeh had the highest tolerant to salinity.

Key words: *Medicago sativa*, Lucerne, alfalfa salt tolerance, Variation

INTRODUCTION

As the world population continues to increase and the amount of arable land decrease, a greater emphasis must be placed on bringing marginally productive and presently non-arable land under production. Much of the world's non-arable land is affected by salinity (Allen *et al*., 1985). Large amounts of formerly arable lands are being removed from crop production every year due to increasing soil salinity. Salinity limits crop yields on nearly one-third of the world's irrigated land and salinization continues to increase worldwide (McKell *et al*., 1986). Much of the cropland affected by salinity is in traditional alfalfa decreases 7.3% for each dS m-1(≈11mM NaCl) increase above a threshold of 2.0 dS m-1 (≈ 22 mM NaCl). Seedling alfalfa yield is decreased by 50% at 8.9 dS m-1 (≈97 mM NaCl) (Mass & Hoffman, 1977). Reclamation, drainage, and improved irrigation practices might reduce the severity and spread of salinization in some regions, but costs of these practices are generally prohibitive. Plant breeding may provide a relatively cost effective short-term solution to the salinity problem by producing cultivars able to remain productive at low to moderate levels of salinity (Johnson *et al*., 1993). However, breeding for improved salt tolerance in many crops plants, including alfalfa has progressed slowly (Blum, 1988; Johnson *et al*., 1992; Nobel *et al*., 1984).

Development of salt tolerance in crops depends ultimately on two factors. First, availability of genetic variation with respect to tolerance, and second, exploitation of available genetic variation by screening and selection of those plants with superior performance when exposed to such stress

(Epstein *et al*., 1980; Shannon., 1984). The presence of phenotypic variation for salt tolerance at the seedling stage was reported for 35 alfalfa cultivars (Al-Khatib., 1991). It might there fore be that selection of highly salt tolerant genotypes between and within cultivars could be expected to provide useful material for further breeding, and for experimental comparisons (Al-Khatib *et al*., 1993). Alfalfa (*Medicago sativa*) is one of the most important cultivated forage legumes in Iran, but the main alfalfa producing areas is Azarbaijan region in the north- west. There are very rich alfalfa germplasm, so more variation expected for traits. This research as a part of synthetic variety improvement project with polycross and progeny test was carried out with native alfalfa ecotypes. The objectives of this study were to determine: (i) phenotypic variation between cultivars at different salinity levels, and (ii) change in forage yield resulting from saline stress.

MATERIALS and METHODS

The experiment was carried out at East Azarbaijan Agriculture and Natural Resources Research Center (AZARAN), Iran. Five Azarbaijan native alfalfa cultivars, Syah-Roud, Gara-Yongeh, Hasht-Roud, Khor-Khor and Bash-Kand were used in this experiment. Five sterilized seeds of each five cultivars were sown in individual 40cm × 75cm pots containing 12 kg loamy sand soils, covered with sand to depth of 10mm (Assadian & Miyamoto., 1987). The saturation extract of this soil had a pH of 7.4 and an Ec of 3.07 (mm mohs). Four salt levels were 3.07, 10, 20 and 30 (mm mohs) that they achieved by adding 0, 1.062, 2.931 and 5.071 g kg^{-1} NaCl to pots soil, respectively.

All treatments were watered to field capacity daily with non-saline water (Assadian & Miyamoto., 1987). Forage from each plant was harvested at 10% bloom by clipping 4 cm above the crown, and total dry weight (TDW), leaves dry weight (LDW), shoot dry weight (SDW), height (H), number of leaves (NL) and dry leaf/stem ratio (DLS) were measured for each plant 59, 104, 137, 160 and 200d post-planting. In our experiment a completely randomized design with 5×4 factorial arrangements and three replication were used. Factors were ecotypes (Syah-Roud, Gara-Yongeh, Hasht-Roud, Khor-Khor and Bash-Kand) and salt levels (0, 1.062, 2.931 and 5.071 g kg^{-1} NaCl). All treatments were replicated four times.

RESULTS and DISCUSSION

An ANOVA (Table 1) indicated that the response was significantly different among germplasm sources ($P<0.01$) as well as NaCl levels ($P<0.01$) and the interaction effect of cultivar×NaCl wasn’t significant for all measured traits, except for DLS. The total means of trails of five cultivars are given in Table 2.

Ecotypes had differing responses to increasing NaCl concentration. Syah-Roud, Gara-Yonjeh and Hasht-Roud cultivars had the highest yield in no-salt condition, respectively. Syah-Roud and

Gara-Yonjeh ranked higher in percentage yields than other cultivars; however, there was no significant difference between them. Bash-Kand cultivar ranked substantially lower than other cultivars.

The NaCl effect was significant in reducing all measured traits of all five ecotypes. All traits under the salt treatments were significantly lower ($P<0.01$) than no-salt condition for all cultivars. All cultivars yields reduced significantly ($P<0.01$) by the salt treatment(Tabel 3).

Clearly from the outcome of the study, genetic variation seems to exist between cultivars, which, as has been a requirement for breeding program to improve salt tolerance (Al-Khatib *et al.*, 1993). The screening method used in this study for five cultivars was sufficient to isolate tolerant cultivars. Although tolerance to salinity at the germination and seedling stages is highly desirable (Raghra Ram & Nabors., 1985), tolerance of the resultant adult plants is of equivalent importance. The link between the detection of variation in response to salinity and the breeding of salt tolerant crop is the knowledge that the phenotypic variation observed has to at least some degree a genetic basis (Al-Khatib *et al.*, 1993). It would seem likely from the data presented here about phenotypic variability in response to NaCl, and the implied genetic basis of that variability, that further significant advances in NaCl tolerance in alfalfa may be archived.

Table 1. Analysis of variance for total dry weight (TDW) leaves dry weight (LDW), shoot dry weight (SDW), height (H), number of leaves (NL) and dry leave/stem ratio (DLS) of five cultivars in four NaCl concentrations.

S.O.V.	df	MS					
		TDW (g)	LDW (g)	SDW (g)	H (cm)	NL	DLS
NaCl con. (C)	3	30.18**	17.86**	12.37**	148.79**	45.87**	0.29**
Cultivar (V)	4	4.27**	2.57**	1.81**	26.33**	2.53**	0.21**
C * V	12	0.42 $^{n.s}$	0.43 $^{n.s}$	0.17 $^{n.s}$	3.03 $^{n.s}$	1.85 $^{n.s}$	0.18 **
Error	40	0.39	0.28	0.19	2.82	0.493	0.07

**, *, and ns, Significant at 0.01, 0.05 and non significant, respectively.

Table 2. The total mean of TDW, LDW, SDW, H and NL of five cultivars ٭

Cultivar	TDW (g)	LDW (g)	SDW (g)	H (cm)	NL
Syah-Roud	4.96	3.01	1.76	80.52	12.61
Gara-Yongeh	4.81	3.19	1.67	78.81	12.93
Hasht-Roud	3.45	2.06	1.34	72.02	11.48
Khor-Khor	2.42	1.54	0.85	56.28	9.39
Bash-Kand	2.18	1.48	0.67	49.83	9.19
LSD5%	0.30	0.25	0.21	0.80	0.47

٭. The abbreviations in this table same as table 1.

Table 3. Forage parameters of five Lucerne ecotypes in salty treatments and control •

NaCl(Ec,mm mohs)	TDW (g)	LDW (g)	SDW (g)	H (cm)	NL
Control	8.63	5.22	3.31	110.04	470.45
10	4.23	2.86	1.38	76.91	200.78
20	1.52	0.96	0.54	45.29	47.45
30	1.46	0.95	0.47	45.15	53.61
LSD5%	0.269	0.226	0.188	0.715	3.144

•. The abbreviations in this table same as table 1.

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