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INVESTIGATION OF SALINITY TOLERANCES OF SOME ANNUAL GRASS TYPES IN VIVO

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Current Trends in Natural Sciences

Abstract
The aim of present study; determination of the salt tolerance of annual grass cultivars in vivo pot experiment. In the study, 25 registered grass varieties were used as material. Salt concentrations of 150 mM NaCl were applied to determine the response of annual grass varieties to salt stress. Root length, shoot length, root-shoot fresh weight and root-shoot dry weight were examined in vivo pot experiment. In the characteristics examined in the pot experiments, two stages were examined: first cutting and second cutting and plant height, shoot fresh weight and shoot dry weight values were examined in salt and control applications. In terms of these examined characteristics, the lowest value in the first cutting control group was obtained from Quickston and Vallivert varieties, while the highest value was obtained from Rambo, Tetra and Ration varieties. Again, in the first form salt application, the lowest value was obtained from Quickston and Vallivert varieties, while the highest value was obtained from Devis, Baqueno and Hellen varieties. In the second cutting control group, the lowest value was obtained from Quickston, Venus varieties, while the highest value was obtained from Rambo, Baqueno, Vallivert varieties. Again, in the second form salt application group, the lowest value was obtained from Kartetra, Quickston, Efe varieties, and the highest value was obtained from Teanna, Jako, Master varieties. As the result of present study, the obtained variation among the annual grass varieties used in the study can be used both in the grass application and in breeding programs.

Keywords: Annual grass, salt stress testing

1. INTRODUCTION

Salinity, one of the abiotic stress factors, affects plant growth and limits crop productivity, especially in arid and semi-arid regions (Çulha and Çakırlar, 2011). Salt stress causes significant losses in plant yield and quality, especially by changing soil structure, physiological drought, ion toxicity and ion imbalances (Zhang et al. 2012). In addition, salt ions such as Na and Cl are easily absorbed by plants and cause many problems. In particular, ion toxicity caused by high levels of Na+ ion accumulation causes disruptions in biochemical reactions in the seed and prevents seed germination (Aydın and Atıcı, 2015). It is reported that salt stress is effective in all developmental stages of plants, but the most sensitive period in many plant species is the germination period (Kuşvuran et al. 2007). It has been reported that the main reason for the negative effect of high salt concentration during the germination period is the inhibition of water uptake into the seed (Aydınşakir et al. 2012). The amount of saline land worldwide is increasing day by day. The use of salt tolerant species could be a solution for regions with saline soils. It is necessary to find salt tolerant plants, such as grasses, to grow on these saline lands (Wu et al. 2015).

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Italian ryegrass (*Lolium multiflorum* Lam.) is a forage crop that demonstrates moderate tolerance to saline water conditions. It is a fast-growing, tall forage crop that can take more than one form under favourable climatic and soil conditions, and is suitable for growing as a mixture with annual legume and wheatgrass forage crops as well as growing alone. In terms of its agricultural characteristics, annual grass is a fodder plant whose production in field agriculture has increased rapidly in recent years and has the potential to increase further due to its rapid growth, abundant grass production, positive response to fertiliser in irrigated conditions, taking part in crop rotation and being a single year (Tassever, 2019). Thanks to these features, it has become popular to grow annual ryegrass (*Lolium multiflorum*) as a forage crop in recent years.

Annual grass is a highly nutritious feed source that can be used for feeding and development of dairy cows, especially in milk production (Taşsever, 2019), used as feed for fattening cattle through grazing, dried and used as hay or fed as silage (Kusvuran and Tansi, 2011; Durst et al. 2013). Moreover, the plant plays a pivotal role in soil amelioration through the deposition of substantial organic matter within the soil profile (Elçi, 2005; Tassever, 2019). It is considered a pivotal forage crop, particularly conducive to the production of high-quality grass, owing to its elevated protein content, abundance of minerals, and water-soluble carbohydrates (Kusvuran and Tansi, 2005). Research has demonstrated that Italian ryegrass has a favourable impact on milk yield and composition (Miller et al., 2001; Bernard, 2003) and enhances the live weight of animals (De Villiers et al., 2002; Zaman et al., 2002; Van Niekerk et al., 2008) due to its high (71% to 78%) dry matter digestibility (Catanese et al., 2009; Amaral et al., 2011).

With the increasing demand for annual grass, many varieties suitable for ecological conditions have been registered in Turkey as in other countries (Kayaalp, 2019). The interest of farmers in this plant is increasing day by day. In order to achieve success in the domain of field agriculture, it is imperative to select the most suitable variety and to possess the knowledge necessary for its cultivation (Arslan and Cakmakçı, 2004). It is acknowledged that each variety possesses a unique set of characteristics, strengths and weaknesses. It is imperative that these characteristics are thoroughly understood within the context of the cultivation environment. The adaptation of varieties to regional conditions is of paramount importance in terms of yield and quality characteristics. The salt tolerance level of newly developed varieties exhibits significant variation according to the variety. However, the paucity of research in this area is evident. The present study was therefore undertaken to determine the tolerance of annual grass cultivars registered in Turkey and widely used in production to soil salinity under in vivo conditions.

2. MATERIALS AND METHODS

In the study, 25 different annual grass varieties registered in Turkey were used as plant material (Table 1)

Pot Trials

The seeds were sown in pots prepared as a mixture of peat and perlite and salt application started after the emergence of the plants. The mixture was made as 1/5 perlite/peat and the soil was weighed and placed equally in all pots. In order to determine the water holding capacity of the mixture in the pots, they were saturated with water and weighed when the infiltration was over. Thus, leakage was prevented during watering. NaCl salt water was applied to the pots 4 times. In the first two, 140 ml and in the last two, 210 ml NaCl saline was applied. The amount of salt in the soil reached 150 mM. The pots are 15 cm tall and 16 cm in diameter. 10 seeds were sown in each pot. The experiment was established with 4 replications. 1 mowing was done and harvested during

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the cultivation period. The first mowing was done 46 days after the emergence of the plants. After mowing, shoot length was measured, wet weights were taken and the samples were dried. Harvesting was done 11 days after the first harvest. Shoot and root lengths were determined during harvesting. plant height(cm), plant shoot fresh weight(g), plant shoot dry weight(g), root lenght(cm), root fresh weight(gr/m^3), root dry weight(gr/m3) were determined.

3. RESULTS AND DISCUSSIONS

3.1. Plant height(cm)

First cutting plant height values of annual grass cultivars grown under salt stress are given in Table 1. The effect of salt application on plant height values of grass cultivars was found statistically significant at 1% level.

Table 1. Plant height values of annual grass cultivars grown in pots under salt treatment

Cultivars	1.Cutting			2.Cutting		
	Control	NaCI(150 mM)	%Efficiency	Control	NaCI(150 mM)	%Efficiency
Vallivert	36.28^{I}	32.72^{GH}	90.2	19.60^{GHI}	10.63^{A-E}	54.2
Master	38.00^{HI}	$33.85F^{GH}$	89.1	23.50^{A-D}	12.13^{AB}	51.6
Hellen	46.07^{D-G}	37.73^{C-H}	81.9	23.00^{A-E}	11.00^{A-D}	47.8
Venus	50.12^{B-F}	39.35^{C-G}	78.5	16.31^{IJ}	9.13^{C-H}	56.0
Excellent	50.97^{BCD}	34.95^{D-H}	68.6	22.63^{A-F}	8.94^{D-I}	39.5
BigBoss	45.55^{D-G}	37.62^{C-H}	82.6	22.31^{A-G}	11.88^{ABC}	53.2
Jivet	44.83^{EFG}	35.40^{D-H}	79.0	21.31^{D-H}	7.31^{GHI}	34.3
Cesco	52.17^{ABC}	41.03^{BCD}	78.6	25.60^{ABC}	9.31^{B-H}	36.4
Trinova	43.42^{GH}	34.15^{E-H}	78.7	22.00^{B-G}	9.75^{B-G}	44.3
Tornado	50.00^{B-F}	35.88^{C-H}	71.8	20.13^{E-H}	7.25^{GHI}	36.0
İlk Adım	48.75^{C-G}	41.27^{BCD}	84.7	24.13^{A-D}	7.19^{GHI}	29.8
Ration	50.17^{B-F}	37.47^{C-H}	74.7	22.69^{A-F}	9.56^{B-H}	42.1
Quickston	31.98^{I}	18.80^{I}	58.8	15.50^{J}	7.75^{F-I}	50.0
Jako	34.75^{I}	31.47^{H}	90.6	22.25^{B-G}	12.79^{A}	57.5
Elif	43.67^{GH}	42.42^{ABC}	97.1	22.50^{A-F}	9.25^{C-H}	41.1
Braulio	55.42^{AB}	42.08^{ABC}	75.9	22.75^{A-F}	9.44^{B-H}	41.5
Baqueno	51.05^{BCD}	39.27^{C-G}	76.9	22.88^{A-F}	9.38^{B-H}	41.0
Kar Tetra	55.08^{AB}	47.67^{AB}	86.5	22.75^{A-F}	6.13^{I}	26.9
Devis	55.58^{AB}	48.75^{A}	87.7	25.19^{AB}	9.50^{B-H}	37.7
Rambo	57.08^{A}	40.67^{CDE}	71.3	25.56^{A}	10.56^{A-F}	41.4
Teanna	45.62^{D-G}	36.92^{C-H}	80.9	23.13^{A-E}	13.13^{A}	56.8
Efe 82	47.50^{C-G}	40.15^{C-F}	84.5	22.94^{A-E}	7.56^{GHI}	33.0
Medoacus	53.17^{ABC}	42.08^{ABC}	79.1	21.88^{C-G}	8.00^{E-I}	36.6
Caramba	50.80^{B-E}	40.58^{CDE}	79.9	19.63^{FGH}	6.81^{HI}	34.7
Koga	44.77^{FG}	37.67^{C-H}	84.1	18.31^{HIJ}	7.25^{GHI}	39.6

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Plant height varied between 31,98 cm and 57,08 cm in the first mowing control treatment. The lowest plant height value was obtained from Quickston variety and the highest plant height value was obtained from Rambo variety. In the first cutting salt treatment, plant height values varied between 18,80 cm and 48,75 cm. The lowest plant height value was obtained from Quickston variety and the highest plant height value was obtained from Devis variety. The effect of cultivar and salt application on plant height was statistically significant at 1% level in the second as well as in the first form. Plant height varied between 15,50 cm and 25,56 cm in the control group and between 6,13 cm and 13,13 cm in the salt treatment. The smallest plant height values were obtained from Quickston and Kar Tetra varieties in the control and salt group, respectively, while the highest values were obtained from Rambo and Teanna varieties, respectively. In the second form of salt treatment, Tornado and Koga gave the same measurement with a plant height value of 7,253 cm. While the efficiency of genotypes in terms of plant height in NaCl application varied between 26,9-57.5%, the highest efficiency was obtained in the Jako variety and the lowest efficiency was obtained in the Kar Tetra variety.

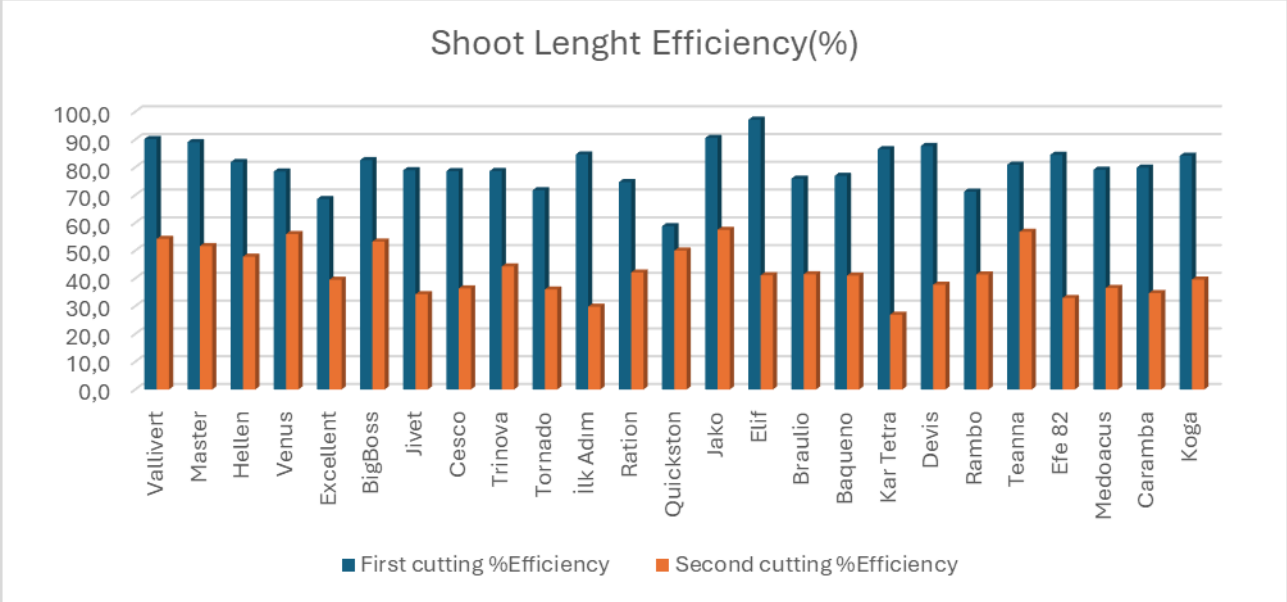

Figure 1. Shoot lenght efficiency (%) of annual grass genotypes

3.2. Plant Shoot Fresh weight (g)

Table 2 shows the shoot fresh weights obtained from the first mowing of annual grass cultivars grown at different salt levels and control treatments. The effect of salt application and cultivars on shoot fresh weights was statistically significant ($p \leq 0.01$). In the control group, the lowest shoot fresh weights was obtained from Vallivert cultivar with 1194,27 g and the highest value was obtained from Kar Tetra cultivar with 2811,50 g. In salt treatment, the lowest value was obtained from Vallivert variety with 1044,98 g and the highest value was obtained from Baqueno variety with 2089,97 g. The cultivars with the same values in the measurements made in the first form were Bigboss and Medoacus with 2363.70 g shoot fresh weights in the control group; Devis, Brauliu with 2040.21 g shoot fresh weights; Kartetra, Medoacus with 1965,57 g shoot fresh weights; Master,

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Jako with 1491,83 g shoot fresh weights; Koga, Efe with 1418,19 g shoot fresh weights in the salt treatment group.

The effect of cultivar and salt application on shoot fresh weights was found to be statistically significant at 1% level in the second as well as in the first form. The fresh weight of green parts varied between 283,89-542,65 g in the control group and 133,61-395,10 g in the salt treatment. The lowest value was obtained from Venus variety in the control group and Quickston variety in the salt treatment. The highest values were obtained from Baqueno variety in the control group and Jako variety in the salt treatment. While the efficiency of genotypes in terms of plant shoot fresh weight in NaCl application varied between 32,2-85,9%, the highest efficiency was obtained in the Vallivert variety and the lowest efficiency was obtained in the Quickston variety.

Table 1. Fresh weight values of green parts of annual grass cultivars grown in pots under salt treatment

Cultivars	1.Cutting			2.Cutting		
	Control	NaCI(150 mM)	%Efficiency	Control	NaCI(150 mM)	%Efficiency
Vallivert	1194.27^{K}	1044.98^{K}	87.5	442.87^{C-H}	380.42^{A}	85.9
Master	1517.71^{IJK}	1492.83^{E-I}	98.4	484.42^{A-E}	324.44^{B}	67.0
Hellen	1965.57^{E-I}	1766.52^{CD}	89.9	489.15^{A-D}	262.24^{C-F}	53.6
Venus	1990.45^{D-H}	1393.31^{IJ}	70.0	283.89^{L}	198.55^{G-J}	69.9
Excellent	2239.25^{B-G}	1542.60^{E-I}	68.9	468.75^{B-F}	252.54^{C-G}	53.9
BigBoss	2363.65^{A-F}	1443.07^{GHI}	61.1	447.85^{C-H}	242.83^{C-G}	54.2
Jivet	2438.3^{A-D}	1741.64^{CD}	71.4	423.72^{D-I}	250.55^{C-G}	59.1
Cesco	2264.13^{B-F}	1642.12^{DEF}	72.5	422.22^{D-I}	227.41^{D-H}	53.9
Trinova	2065.09^{C-H}	1617.24^{D-G}	78.3	500.85^{ABC}	267.47^{C-F}	53.4
Tornado	2289.01^{B-F}	1467.95^{F-I}	64.1	439.39^{C-H}	166.95^{IJK}	38.0
İlk Adım	2562.7^{AB}	1244.0^{3J}	48.5	314.24^{KL}	146.05^{JK}	46.5
Ration	2612.46^{AB}	1517.71^{E-I}	58.1	542.4^{A}	263.73^{C-F}	48.6
Quickston	1667.0H^{IJ}	746.42^{L}	44.8	414.76^{F-I}	133.61^{K}	32.2
Jako	1791.4^{G-J}	1492.83^{E-I}	83.3	498.86^{ABC}	395.10^{A}	79.2
Elif	2189.49^{B-G}	1592.36^{D-H}	72.7	385.90^{HIJ}	264.23^{C-F}	68.5
Braulio	2637.34^{AB}	2040.21^{A}	77.4	493.38^{ABC}	274.93^{BCD}	55.7
Baqueno	2413.42^{A-E}	2089.97^{A}	86.6	542.65^{A}	272.44^{B-E}	50.2
Kar Tetra	2811.5^{A}	1965.57^{AB}	69.9	417.74^{E-I}	182.13^{H-K}	43.6
Devis	2463.18^{ABC}	2040.21^{A}	82.8	395.10^{GHI}	295.33^{BC}	74.7
Rambo	2786.62^{A}	1841.16^{BC}	66.1	461.78^{B-G}	243.83^{C-G}	52.8
Teanna	2512.94^{ABC}	1368.43^{IJ}	54.5	520.75^{AB}	216.46^{F-I}	41.6
Efe 82	2587.58^{AB}	1418.19H^{IJ}	54.8	455.07^{B-G}	219.45^{E-I}	48.2
Medoacus	2363.65^{A-F}	1965.57^{AB}	83.2	436.16^{C-H}	297.07^{BC}	68.1
Caramba	1915.8^{F-J}	1667.00^{CDE}	87.0	361.51^{IJK}	212.98^{F-I}	58.9
Koga	1467.95^{JK}	1418.19^{HIJ}	96.6	324.44^{JKL}	236.12^{D-H}	72.8

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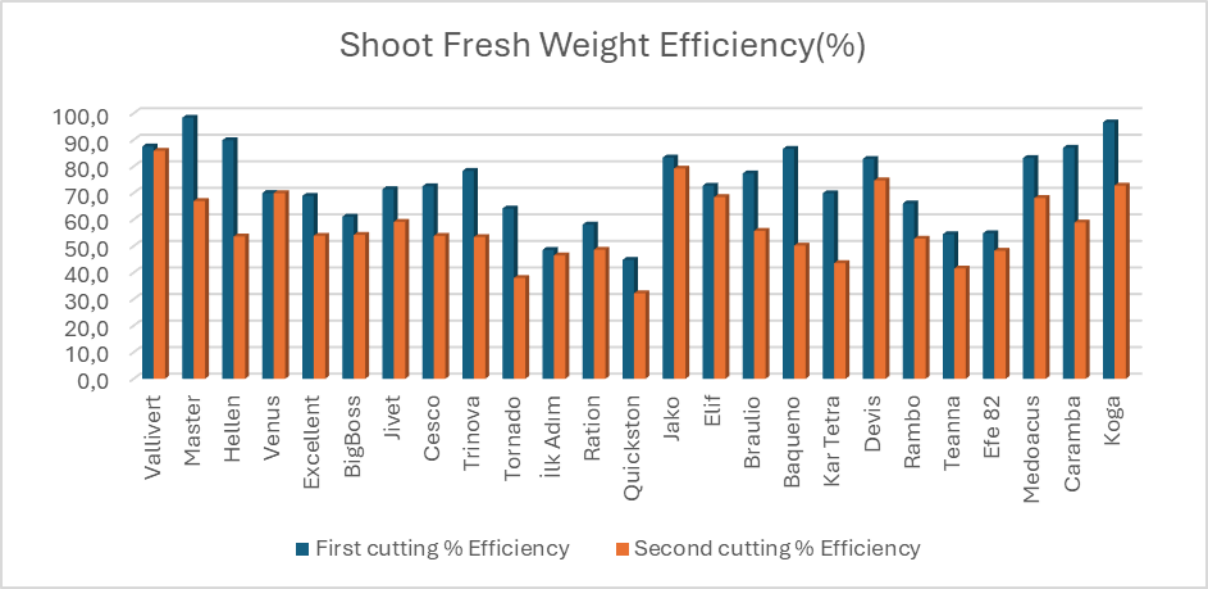

Figure 2. Shoot fresh weight efficiency (%) of annual grass genotypes

3.3. Plant Shoot Dry Weight(g)

Shoot dry weight values of annual grass cultivars are given in Table 3. The effect of cultivar and salt application on dry weight of shoot was statistically significant at 1% level. The shoot dry weights in the first cutting varied between 203,52-497,11 g in the control group and 197,05-265,18 g in the salt treatment. The lowest values were obtained from Vallivert variety in both treatments. The highest value was obtained from Ration variety in the control group and from Hellen variety in the salt treatment. In the first cutting, Trinova and Medoacus varieties gave the same values with 258,80 g shoot dry weights in the control group.

The effect of cultivar and salt on the dry weight values of shoots in the second growth of the grasses was statistically significant ($p \leq 0.01$). In the control group, the lowest shoot dry weight was obtained from Venus cultivar (26,37 g) and the highest value was obtained from Vallivert cultivar (58,22 g). The lowest shoot dry weight was obtained from Efe 82 variety (17,42 g) and the highest value was obtained from Master variety (46,78 g) in the second form of salinized grasses. Braulio, Bigboss with 46,28 g shoot dry weight; Cesco, Devis with 39,81 g shoot dry weight; Medoacus, Elif with 35,33 g shoot dry weight; Teanna, Ration with 30,85 g shoot dry weight; Rambo, Tornado with 24.88 g shoot dry weight gave the same values in the second cutting control group. While the efficiency of genotypes in terms of plant shoot dry weight in NaCl application varied between 44,2-96,2 %, the highest efficiency was obtained in the Venus variety and the lowest efficiency was obtained in the Quickston variety.

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Table 2. Dry weight values of shoot parts of annual grass cultivars grown in pots under salt treatment

Cultivars	1.Cutting			2.Cutting		
	Control	NaCI (150 mM)	%Efficiency	Control	Tuz (150 mM)	Control
Vallivert	203.52^{T}	197.05^{S}	96.8	58.22^{A}	45.78^{B}	78.6
Master	245.82^{L}	215.47^{O}	87.7	53.24^{B}	46.78^{A}	87.9
Hellen	279.16^{C}	265.18^{A}	95.0	41.30^{M}	25.88^{P}	62.7
Venus	239.85^{M}	228.85^{G}	95.4	26.37^{V}	25.38^{Q}	96.2
Excellent	262.74^{G}	214.97^{P}	81.8	46.78^{F}	32.34^{G}	69.1
BigBoss	268.71^{E}	227.91^{H}	84.8	46.28^{G}	31.85^{H}	68.8
Jivet	283.14^{B}	238.36^{E}	84.2	45.28^{I}	26.87^{O}	59.3
Cesco	257.27^{J}	243.33^{B}	94.6	39.81^{N}	29.36^{M}	73.8
Trinova	258.76^{I}	226.41^{J}	87.5	50.76^{C}	31.35^{I}	61.8
Tornado	276.67^{D}	218.45^{M}	79.0	45.78^{H}	24.88^{R}	54.3
İlk Adım	264.23^{F}	202.53^{Q}	76.6	28.86^{U}	21.89^{U}	75.8
Ration	497.11^{A}	240.35^{D}	48.3	43.79^{K}	30.85^{J}	70.4
Quickston	199.54^{U}	110.97^{Y}	55.6	42.79^{L}	18.91^{V}	44.2
Jako	189.59^{X}	178.14^{V}	94.0	49.26^{D}	43.29^{C}	87.9
Elif	190.09^{W}	165.7^{W}	87.2	35.33^{S}	28.86^{N}	81.7
Braulio	246.32^{K}	227.41^{I}	92.3	46.28^{G}	36.33^{D}	78.5
Baqueno	233.38^{P}	230.89^{F}	98.9	48.77^{E}	23.89^{S}	49.0
Kar Tetra	234.87^{O}	222.38^{K}	94.7	37.32^{P}	23.39^{T}	62.7
Devis	235.87^{N}	221.44^{L}	93.9	39.81^{N}	34.83^{E}	87.5
Rambo	197.55^{V}	184.07^{T}	93.2	38.81^{O}	24.88^{R}	64.1
Teanna	230.89^{Q}	182.62^{U}	79.1	44.79^{J}	30.85^{J}	68.9
Efe 82	221.44^{R}	149.28^{X}	67.4	36.82^{Q}	17.42^{W}	47.3
Medoacus	258.76^{I}	241.84^{C}	93.5	35.33^{S}	32.83^{F}	92.9
Caramba	260.25^{H}	216.96^{N}	83.4	33.84^{T}	29.86^{L}	88.2
Koga	213.48^{S}	197.55^{R}	92.5	36.33^{R}	30.35^{K}	83.5

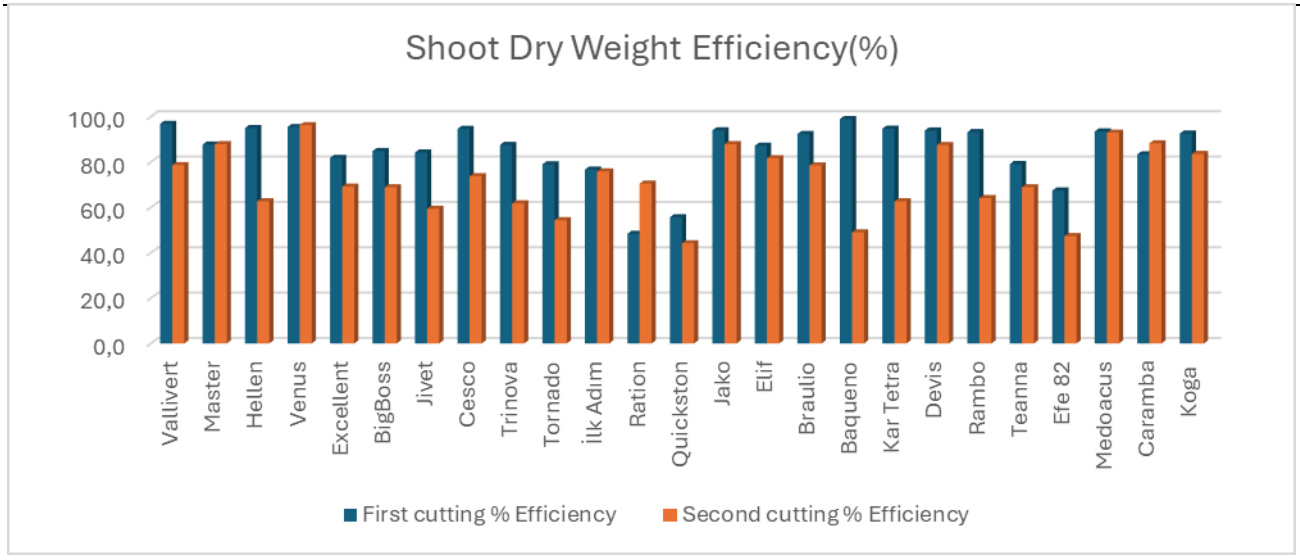

Figure 3. Shoot dry weight efficiency (%) of annual grass genotypes

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3.4. Root lenght(cm)

The values of root length of different annual grass cultivars with salt application are given in Table 4. The effect of cultivar and salt application on root length of grasses was found statistically significant at 1% level. In the control group, root length varied between 16,50 cm and 23,00 cm. The lowest value was obtained from Tornado and the highest value was obtained from Teanna variety. In salt treatment, root length varied between 12,00 cm and 19,00 cm. The lowest root length was obtained from Cesco and the highest value was obtained from Teanna. The varieties with the same value in root length were Bigboss and Caramba with 21,5 cm root length; Baquena, Hellen with 21 cm root length; Efe, Medoacus, Master, Ration with 20 cm root length; Kartetra, Elif with 19 cm root length; Braulio, Koga, Cesco, Quickston with 18,5 cm root length; Trinova, Excellen, Venus, Devis with 18 cm root length; Tornado, Ilkadim with 17 cm root length. In the salt treated group, Baqueno, Kartetra with 18 cm root length; Medoacus, Jivet, Devis, Jako, Elif with 17 cm root length; Braulio, Bigboss with 16,75 cm root length; Ilkadim, Tornado with 16,50 cm root length; Efe, Tirinova, Rambo with 16 cm root length; Caramba, Excellen, Vallivert with 14,50 cm root length; Venus, Hellen, Quickston with 13,50 cm root length. While the efficiency of genotypes in terms of root lenght in NaCl application varied between 64,3-97,1 %, the highest efficiency was obtained in the Tornado variety and the lowest efficiency was obtained in the Hellen variety.

Table 3. Root length values of annual grass cultivars grown in pots under salt treatment

Cultivars	Control	NaCI(150 mM)	% Efficiency
Vallivert	22.50^{A}	14.50^{DE}	64.4
Master	20.00^{BCD}	$17.50A^{BC}$	87.5
Hellen	21.00^{ABC}	13.50^{EF}	64.3
Venus	18.00^{DEF}	13.50^{EF}	75.0
Excellent	18.00^{DEF}	14.50^{DE}	80.6
BıgBoss	21.50^{AB}	16.75^{BC}	77.9
Jivet	19.75^{B-E}	$17.00A^{BC}$	86.1
Cesco	18.50^{DEF}	12.00^{F}	64.9
Trinova	18.00^{DEF}	16.00^{CD}	88.9
Tornado	17.00^{F}	16.50^{BCD}	97.1
İlk Adım	17.00^{F}	16.50^{BCD}	97.1
Ration	20.00^{BCD}	18.50^{AB}	92.5
Quickston	18.50^{DEF}	13.50^{EF}	73.0
Jako	22.00^{AB}	17.00^{ABC}	77.3
Elif	19.00^{C-F}	17.00^{ABC}	89.5
Braulio	18.50^{DEF}	16.75^{BC}	90.5
Baqueno	21.00^{ABC}	18.00^{ABC}	85.7
Kar Tetra	19.00^{C-F}	18.00^{ABC}	94.7
Devis	18.00^{DEF}	17.00^{ABC}	94.4
Rambo	17.50^{EF}	16.00^{CD}	91.4
Teanna	23.00^{A}	19.00^{A}	82.6
Efe 82	20.00^{BCD}	16.00^{CD}	80.0
Medoacus	20.00^{BCD}	17.00^{ABC}	85.0
Caramba	21.50^{AB}	14.50^{DE}	67.4
Koga	18.50^{DEF}	12.75^{EF}	68.9

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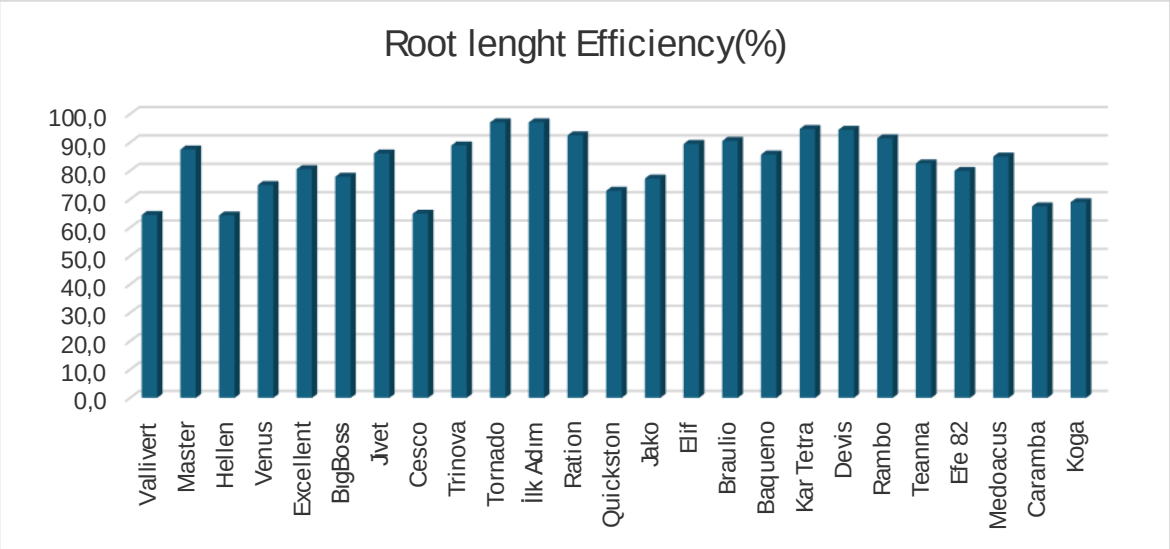

Figure 4. Root lenght efficiency (%) of annual grass genotypes

3.5 Root Fresh Weight(gr/m^3)

Root fresh weight values of annual grasses grown under saline and control conditions are given in Table 5. The effect of cultivar and salt application on root fresh weight was statistically significant at 1% level. In the control group, the lowest root fresh weight value was obtained from Jako variety (825,70 g/m3) and the highest value was obtained from Trinova variety (3403,90 g/m3). In salt treatment, the lowest value was obtained from Koga variety (495,00 g/m3) and the highest value was obtained from Baqueno variety (2127,44 g/m3). While the efficiency of genotypes in terms of root fresh weight in NaCl application varied between 23,9-97,2 %, the highest efficiency was obtained in the Master variety and the lowest efficiency was obtained in the Hellen variety.

Table 5. Root fresh weight values of annual grass cultivars grown in pots under salt treatment

Cultivars	Control	NaCI (150 mM)	% Efficiency
Vallivert	1383.89^{E-H}	973.14^{E-J}	70.3
Master	1588.2^{EFG}	1543.97^{A-F}	97.2
Hellen	3155.34^{AB}	754.08^{IJ}	23.9
Venus	3052.13^{AB}	1758.82^{ABC}	57.6
Excellent	1800.95^{DE}	1666.14^{A-D}	92.5
BıgBoss	1343.87^{E-H}	1192.21^{B-I}	88.7
Jivet	1982.1^{CDE}	1497.63^{A-G}	75.6
Cesco	1866.25^{DE}	1472.35^{A-G}	78.9
Trinova	3403.9^{A}	1558.72^{A-F}	45.8
Tornado	1470.25^{E-H}	1223.8^{B-I}	83.2
İlk Adım	1421.8^{E-H}	1299.63^{B-I}	91.4
Ration	2995.26^{AB}	1855.71^{AB}	62.0
Quickston	1533.44^{E-H}	697.21^{IJ}	45.5

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Jako	825.7^{H}	708.85^{IJ}	85.8
Elif	1750.39^{DEF}	789.89^{HIJ}	45.1
Braulio	1280.67^{E-H}	907.85^{F-J}	70.9
Baqueno	2424.43^{BCD}	2127.44^{A}	87.8
Kar Tetra	1341.76^{E-H}	1025.8^{D-J}	76.5
Devis	1417.59^{E-H}	1124.8^{C-J}	79.3
Rambo	1459.72^{E-H}	1027.91^{D-J}	70.4
Teanna	2696.16^{ABC}	1253.29^{B-I}	46.5
Efe 82	2744.6^{AB}	1449.18^{B-H}	52.8
Medoacus	1640.86^{EF}	1419.8^{A-E}	86.5
Caramba	880.46^{GH}	820.44^{G-J}	93.2
Koga	1000.53^{FGH}	495^{J}	49.5

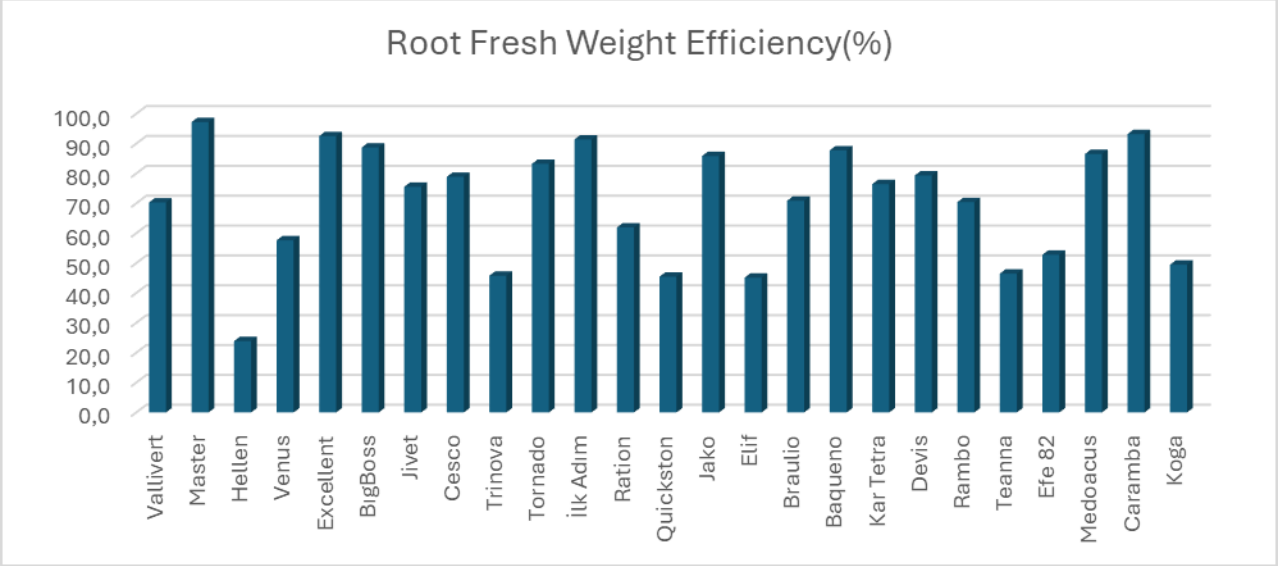

Figure 5. Root fresh weight efficiency (%) of annual grass genotypes

3.6 Root Dry Weight(gr/m^3)

Root dry weight values of grass cultivars are given in Table 6. It was determined that the effect of NaCI application and cultivar on root dry weight was statistically significant at 1% level. Root dry weight varied between 227,46-594,00 g/m^3 in the control group and 80,04-299.10 g/m3 in the salt treatment. The lowest root dry weight values were obtained from Elif and Hellen varieties in the control and salt groups, respectively, while the highest values were obtained from Baqueno and Tornado varieties, respectively. According to the results of the statistical analysis of the root dry weight measurement, there are traits with the same values. In the control group; Efe with 366,50 g root dry weight; Jako; Quickston, Medoacus with 332,80 g root dry weight. In the salt treatment group; Medoacus, Tornado, Kartetra with 299,10 g root dry weight; Braulio, Baqueno with 235,91 g root dry weight; Jako, Jivet with 198 g root dry weight. While the efficiency of genotypes in terms of root dry weight in NaCl application varied between 13,8-90,7 %, the highest efficiency was obtained in the Elif variety and the lowest efficiency was obtained in the Hellen variety.

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Table 6. Root dry weight values of annual grass cultivars grown in pots under salt treatment

Varieties	Control	NaCI(150 mM)	% Efficiency
Vallivert	294.89^{T}	256.47^{I}	87.0
Master	535.02^{D}	286.47^{C}	53.5
Hellen	581.36^{B}	80.04^{U}	13.8
Venus	501.32^{E}	294.89^{B}	58.8
Excellent	358.08^{P}	202.21^{O}	56.5
BıgBoss	374.93^{N}	265.4^{G}	70.8
Jivet	429.7^{G}	198^{P}	46.1
Cesco	420.13^{H}	278.04^{E}	66.2
Trinova	568.72^{C}	269.62^{F}	47.4
Tornado	383.36^{L}	299.1^{A}	78.0
İlk Adım	286.47^{U}	258.04^{H}	90.1
Ration	484.47^{F}	248.55^{J}	51.3
Quickston	332.81^{Q}	151.66^{T}	45.6
Jako	366.51^{O}	198^{P}	54.0
Elif	227.49^{W}	206.42^{N}	90.7
Braulio	391.79^{K}	235.91^{K}	60.2
Baqueno	594^{A}	235.91^{K}	39.7
Kar Tetra	379.15^{M}	299.1^{A}	78.9
Devis	396^{J}	227.49^{M}	57.4
Rambo	307.53^{S}	231.7^{L}	75.3
Teanna	400.21^{I}	282.25^{D}	70.5
Efe 82	366.51^{O}	168.51^{R}	46.0
Medoacus	332.81^{Q}	299.1^{A}	89.9
Caramba	244.34^{V}	164.3^{S}	67.2
Koga	324.38^{R}	172.72^{Q}	53.2

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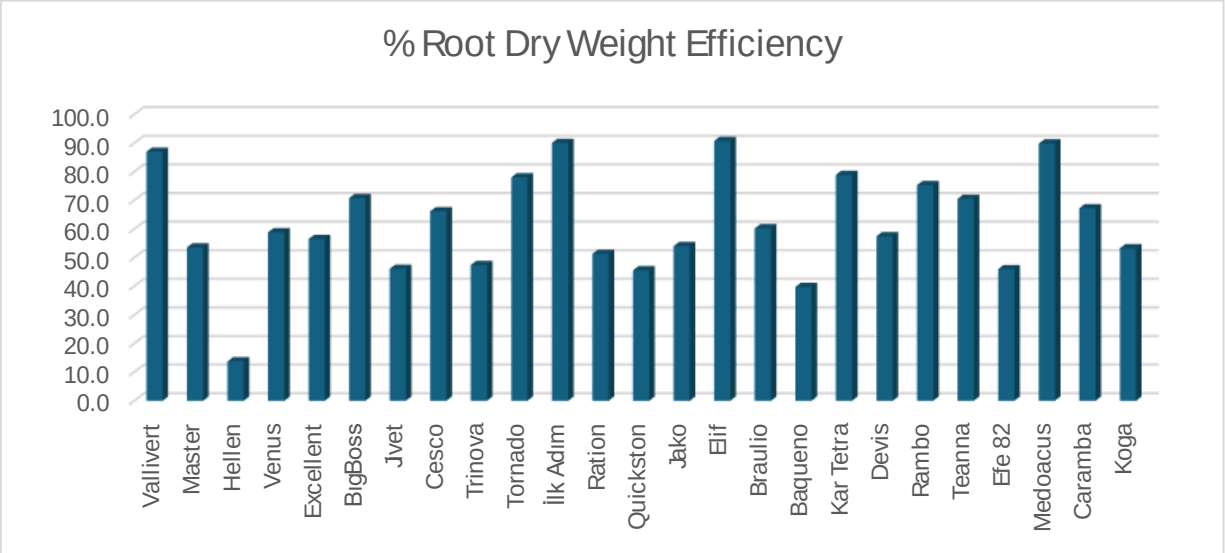

Figure 6. Root dry weight efficiency (%) of annual grass genotypes

It has been documented that genetic variations among varieties exist with regard to their tolerance of salt stress. However, it was determined that increasing salinity had a negative effect on all varieties, with some varieties demonstrating greater tolerance than others (Carpıcı et al. 2009). In the present study, the response of the varieties to salt was found to differ. A substantial body of research has indicated that the genetic response of cultivars to salt stress is variable. Moud and Maghsoudi (2008) observed that wheat cultivars exhibited differential seedling responses to salt stress, with a decline in coleoptile and root growth observed at both elevated salinity levels. The authors concluded that these results indicated that there is genetic variation among cultivars in terms of early seedling growth rate under salt stress conditions. The researchers further concluded that the germination and emergence rates, as well as the length of the coleoptile and the root, can serve as effective selection criteria for salt stress tolerance during the early growth stages. It was further noted that under salt stress conditions, the rate of coleoptile elongation decreases due to low soil water potential (Francios et al. 1986) and that the development of plants remains poor due to poor coleoptile and root growth. This phenomenon has been observed in various plant species, including barley (Huang and Reddman, 1995), tomato (Foolad and Jones, 1993), and bean (Jeannette et al., 2002).

An investigation was conducted into the germination and growth characteristics of grass cultivars in vivo (pot) trials under salt treatment. The responses exhibited by annual grass cultivars to salt stress were found to be diverse. It was observed that the varieties exhibited distinct characteristics under stress conditions as well as under optimum conditions.

In vitro trials were conducted to assess root length, shoot length, root-shoot fresh weight, and root-shoot dry weight. In the control group, the lowest values were recorded for the Efe and Vallivert varieties, while the highest values were recorded for the Medoacus and Trinova varieties. In salt-treated conditions, the Tornado, Vallivert, and Venus varieties exhibited the lowest values, while the Medoacus and Trinova varieties demonstrated the highest values.

The traits that were the focus of the pot trials encompassed plant height, shoot fresh weight, and shoot dry weight. In relation to these traits, the Quickston, Vallivert varieties exhibited the lowest

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values in the first form control group, while the Rambo, Tetra, Ration varieties demonstrated the highest values. In the initial salt treatment, the lowest value was again obtained from Quickston, Vallivert varieties, while the highest value was obtained from Devis, Baqueno, Hellen varieties. In the second form control group, Quickston, Venus gave the lowest value and Rambo, Baqueno, Vallivert varieties gave the highest value. In the salt treatment group, the lowest value was attributed to Kartetra, Quickston, Efe varieties, while the highest value was obtained from Teanna, Jako, Master varieties.

Root length, root width, root fresh weight, root dry weight, root fresh weight, root dry weight were examined among the traits examined in the pot trials. In the control group, the lowest value was given by Tornado, Elif, Caramba, Jako varieties, while the highest value was given by Teanna, Ilkadim, Trinova, Baqueno varieties. In the salt treatment group, the lowest value was given by Cesco, Caramba, Koga, Hellen varieties and the highest value was given by Teanna, Braulio, Baqueno, Tornado varieties.

4. CONCLUSIONS

Accordingly, if grass is to be cultivated in saline soils, their salt tolerance must be determined. However, the plants should also be tested at different salt levels in order to decide on the salt dose.

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