



Screening of Oat (*Avena Sativa*) Varieties in Saline-Sodic Soil

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Abstract

Oat has much privileged sodium ion levels than wheat, soybean, cotton, and other seasonal crops. Oat cultivation is still well thought-out to stand for a supportive biological assess to recover saline lands due to its high capability to accrue salt ions in its straw, which is widely used as forage for livestock. Seeds of Oat (*Avena sativa*) were sown in a pot study to different combinations of salinity and sodicity [$S_0=4.70\text{dSm}^{-1}+19.12\text{ (mmol L}^{-1})^{1/2}$, $S_1=9.02\text{dSm}^{-1}+30.65\text{ (mmol L}^{-1})^{1/2}$ and $S_2=11.35\text{ dSm}^{-1}+34.69\text{ (mmol L}^{-1})^{1/2}$]. Seven oat varieties namely Bulbin, S-2000, Dilawar, PD2LV65, No.667, Bob and Cyprus were used for screening against salt tolerance. The leaset % decrease in grain yield (35.24) was attained in S-2000 oat variety than other varieties. Therefore, this oat variety showed minimum loss due to toxic effects of salinity cum sodicity. Dilawar oat variety attained the highest grain yield (1.38 tha^{-1}) under S_2 [$11.35\text{dSm}^{-1}+34.69\text{ (mmol L}^{-1})^{1/2}$]. Bulbin oat variety received the least position (1.21tha^{-1}) in this salinity level. % decrease at S_2 over S_0 was indicated salt tolerance of oat varieties. Bob oat variety attained the lowest % decrease at S_2 over S_0 (42.27). Therefore, this variety had the maximum salt tolerance other than six oat varieties under this experiment.

Keywords: Oat; Bulbin; S-2000; Dilawar; PD2LV65; No.667; Bob; Cyprus Saline- sodic; Grain yield

Introduction

Oat (*Avena Linn.*) is a vital cereal crop that is cultivated globally for fodder and grain. Oat is one of the oldest crops and is still extensively grown worldwide, including at high latitudes and in limiting climates. Oat is highly healthful for human and cattle utilization. Importance of oat in human nutrition is mounting due to traits e.g. cholesterol-lowering, antioxidant, and other health-related properties of oat and oat products and components [1,2]. The *Avena* genus includes some species referred to as naked oat, whose seeds are not as tightly husked as the others. Among these species, *Avena chinensis* is a leading crop and traditional food for local people in some marginal areas of north China affected by salinity and aridity, thus performing a significant responsibility in the local economy and natural environment [3]. Oat has much higher sodium ion levels comparing to wheat, soybean, cotton, and other seasonal crops [4-7]. Oat farming is still painstaking to signify a cooperative biological way to develop saline lands due to its high ability to gather salt ions in its straw, which is largely consumed as forage for livestock [8]. Nonetheless, abiotic stress tolerance is

a quantitative attribute proscribed by numerous genes [9]. Oat is a type of cereal which is apt for special utilization with the world cool climate cereals and also our motherland. Moreover, being directly used in the human nutrition, oat is also consumed as an important raw material in biscuit industry. Furthermore, its straw and grain are also frequently used for animal nutrition. According to 2013 data, 235 thousand tons oat is produced in Turkey while it has a production volume of 2.4 million tons in the world [10].

Soil salinity is one of the limiting factors for plant production worldwide and the most important abiotic stress [11]. Up to now, approximately 7% of total land area (1,000 million ha) and 20% of the irrigated arable land in arid and semi-arid regions is salt affected and is increasing [12,13]. Salinization of agricultural soils causes reduction in crop growth, yields, and productivity due to ion imbalance and hyperosmotic stress. Sodium (Na^+) and chloride (Cl^-) are the two key ions responsible for significantly reduction in crop growth and yields because of osmotic and ion-specific damage [14]. Therefore, traditional breeding as well as biotechnological

approaches have been undertaken to increase the salt tolerance of plants by [15].

More than 10% of the cultivated are affected with drought and salinity which limit the planting and plant production. Approximately 50% yield losses for many important plants are influenced by desertification and salinization in global level [16]. Salinization damaged approximately 15-20% of cultivated areas and 20-50% of irrigated farming areas of the world [17,18]. Salinity restricts development due to osmotic and ion stress and also indemnity at structural, physiological, biochemical and molecular levels [19].

As salinity stress concentration increases, germination reduced [20-24]. The oat varieties used in our study all had much weaker root development under salinity stress and the root development reduces at stress doses go up [24-30] specified that as the stress factor increased, there was considerable reduction in shoot development, which is one of the most important parameters at determining the stress tolerance of genotypes. With increasing stress, varieties had difficulty in germination and reduction of root / shoot development and fresh weight [31,32]. The utilization of starch stored in the endosperm of the seeds becomes limited at the salinity stress rises [33]. Therefore, this study was planned to evaluate the salt tolerance of oat varieties.

Materials and Methods

A pot study was conducted to evaluate the salt tolerance of oat varieties under different salinity cum sodicity levels [$S_0=4.70\text{dSm}^{-1}+19.12\text{ (mmol L}^{-1})^{1/2}$, $S_1=9.02\text{dSm}^{-1}+30.65\text{ (mmol L}^{-1})^{1/2}$ and $S_2=11.35\text{ dSm}^{-1}+34.69\text{ (mmol L}^{-1})^{1/2}$]. Seeds of seven oat varieties namely Bulbin, S-2000, Dilawar, PD2LV65, No.667, Bob and Cyprus were used for screening against salt tolerance were sown in a pot study to different combinations of salinity and sodicity at green house of Land Resources Research Institute, National Agricultural

Research Centre, Islamabad, Pakistan during, 2018. 10 Kg soil was used to fill each pot. 10 seeds of Oat (*Avena sativa*) were sown in each pot. Fertilizer was applied @60-50-40 NPK Kg ha⁻¹. Completely randomized design was applied with three repeats. Data on grain yield were collected. Collected data were statistically analysed and means were compared by LSD at 5 % [34].

Results and Discussions

Sodium ion level is much elevated in oat than wheat, soybean, cotton, and other seasonal crops [4-7]. Oat cultivation is still measured to signify a supportive biological assess to develop saline lands owing to its high salt ion accumulation capacity in its straw and mostly consumed for livestock forage [8] Data indicated in table-1 showed significant differences in grain yield among seven oat varieties. At S_0 [$4.70\text{dSm}^{-1}+19.12\text{ (mmol L}^{-1})^{1/2}$] Dilawar oat variety attained the highest grain yield (2.44 tha^{-1}) which was statistically similar to No.667oat variety. All other oat varieties under S_0 [$4.70\text{dSm}^{-1}+19.12\text{ (mmol L}^{-1})^{1/2}$] showed similar statistically results. Reduction in germination, root/ shoot development and grain yields with increasing salinity stress [31,32].

No.667oat variety got the top position in producing grain yield (1.52 tha^{-1}) among other oat varieties at S_1 [$9.02\text{dSm}^{-1}+30.65\text{ (mmol L}^{-1})^{1/2}$]. Cyprus oat variety gained the least grain yield (1.35tha^{-1}) that was statistically at par with Bulbin oat variety (Table 1) also depicted very interesting data in % decrease at S_1 over S_0 . The lease % decrease in grain yield (35.24) was attained in S-2000 oat variety than other varieties. Therefore, this oat variety showed minimum loss due to toxic effects of salinity cum sodicity. Salinization causes more than 50% yield losses for many important plants [16]. Sodium (Na⁺) and chloride (Cl⁻) are the two key ions responsible for both osmotic and ion-specific damage, which significantly reduce crop growth and yields [14]. Increasing salinity and sodicity affected inverse on grain yield of these oat varieties as presented in (Table 1).

Table 1: Screening of oat (*Avena sativa*) varieties in saline- sodic soil (Grain yield tha^{-1})

Varieties	S_0	S_1	%decrease at S_1 over S_0	S_2	% decrease at S_2 over S_0
Bulbin	2.25b	1.36d	39.55	1.21d	46.22
S-2000	2.27b	1.47b	35.24	1.24d	45.37
Dilawar	2.44a	1.46abc	40.16	1.38a	43.44
PD2LV65	2.36ab	1.48ab	37.28	1.31bc	44.49
No.667	2.42a	1.52a	37.19	1.36ab	43.8
Bob	2.20b	1.40cd	36.36	1.27cd	42.27
Cyprus	2.23b	1.35d	39.46	1.25cd	43.94
LSD	0.13	0.07	-----	0.07	-----

$S_0 = [4.70\text{dSm}^{-1}+19.12\text{ (mmol L}^{-1})^{1/2}]$ $S_1 = [9.02\text{dSm}^{-1}+30.65\text{ (mmol L}^{-1})^{1/2}]$ $S_2 = [11.35\text{ dSm}^{-1}+34.69\text{ (mmol L}^{-1})^{1/2}]$

Dilawar oat variety attained the highest grain yield (1.38 tha^{-1}) under S_2 [$11.35\text{dSm}^{-1}+34.69\text{ (mmol L}^{-1})^{1/2}$]. Bulbin oat variety received the lease position (1.21tha^{-1}) in this salinity level. % decrease at S_2 over S_0 was indicated salt tolerance of oat varieties. Bob oat variety attained the lowest % decrease at S_2 over S_0 (42.27). Therefore, this variety had the maximum salt tolerance than other six oat varieties under this experiment. As salinity stress concentration

increases, germination reduced [20-23,25]. The oat varieties used in our study all had much weaker root development under salinity stress and the root development reduces at stress doses go up [24-30] investigated that as the salinity raised, the significant reduction in shoot development being the most important parameters to evaluate determining the salt tolerance in various genotypes.

Conclusion

Bulbin oat variety received the lease position (1.21tha^{-1}) under S_2 [$11.35\text{dSm}^{-1} + 34.69$ ($\text{mmol L}^{-1})^{1/2}$]. % decrease at S_2 [$11.35\text{dSm}^{-1} + 34.69$ ($\text{mmol L}^{-1})^{1/2}$] over S_0 [$4.70\text{dSm}^{-1} + 19.12$ ($\text{mmol L}^{-1})^{1/2}$] was indicated salt tolerance of oat varieties. Bob oat variety attained the lowest % decrease at S_2 over S_0 (42.27). Therefore, this variety had the maximum salt tolerance than other six oat varieties under this experiment.

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