Plant Archives Vol. 18, Special Issue (ICAAAS-2018), 2018 pp. 133-136 ***ISSN 0972-5210***

PERFORMANCE OF OAT (*AVENA SATIVA* L.) GENOTYPES FOR SEEDLING TRAITS UNDER VARYING LEVEL OF SALINITY

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Abstract

Soil salinity is one of the most important problem which adversely affects the growth and reproduction of the plant. Present study was conducted to evaluate 14 oat (*Avena sativa* L.) genotypes under different salinity level with objective to understand the effect of salinity on seedling traits and to select tolerant genotypes. The concentrations of potassium and sodium (K^+/ Na^+) uptake in oat at 3 level of salinity i.e. 4 EC dSm^{-1}, 8 EC dSm^{-1}, 12 EC dSm^{-1} were studied. The results showed that values of K^+/ Na^+ ratios in plants were found to be lowered with the increasing level of salinity. Genotypes showed wide range of variations for their response to increasing salinity for germination and seedling traits. Genotypes JHO 822, JHO 851, NGB 6370 and JHO 99-2 were least affected for germination and were found highly tolerant at varying level of salinity. These genotypes also exhibited high K^+ concentration compared to control and high K^+/ Na^+ ratio which also indicated these genotypes are better accumulator of K^+ at high salt concentrations. Conversely, NGB 7021 and OS 6 was sensitive to salinity in terms of the above parameters studied.

Key words : Oat, genotypes, soil salinity, *Avena sativa*.

Introduction

Oat is moderately salt tolerant crop and plant show varying response for long-term salinity in terms of physiological and molecular attributes. Area and production in the country is increasing and crop is spreading fast from northern plain to central and western part of the country including Maharashtra, Rajasthan and Gujarat. Oat is very important dual purpose crop and possess excellent fodder and food qualities. Oat is becoming popular amongst diabetic patients, since the grain contain high cholesterol fighting soluble fibre called beta-glucan (Singh *et al*., 2003). Although, demand for oat as fodder and food crop is increasing but crop production is constrained with many abiotic factors and changing climate increasing the challenges for the cultivation. The major environmental factor that currently reduces plant productivity is salinity (Majeed *et al*., 2010). Increased the salinization of arable lands is expected to have devastating global effect, resulting 30% land losses within the next 25 years and up to 50% by the years the next 25 year 2050 (Wang *et al*., 2003).

Germination ability and seedling traits are most important parameters for salt stress because roots are in direct contact with soil and absorb water from soil and shoot supply it to the rest of plant. However, K^+/ Na^+ ratios of the leaves is most important physiological characters determining salinity tolerance, indicating significant importance to estimate the ion selective mechanism of the genotype. The degree of morphological, biochemical effects of salinity is depends upon the genetic architecture of the genotype, which in turn regulates the extent of response. In oat, existence of wide diversity makes it a suitable candidate for screening the genotypes with suitable parameter to identify the tolerant and susceptible lines for further improvement and programme and development of mapping population.

The present work has been envisaged to evaluate the oat genotypes for existence of inter –genotypic variation for salt tolerance. The biochemical studies on

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the plants growing under stress condition may also reveal the attributes linked to salt tolerance. The study has relevance for selection of salt tolerance at seedling stage and generating basic information related to salt tolerance in oat.

Materials and Methods

Seeds of fourteen genotypes of oat were procured from ICAR-Indian Grassland & Fodder Research Institute, Jhansi and National Gene Bank, NBPGR, Delhi. Details of genotypes are presented in table 1.

Table 1 : Details of oat genotypes used for the study.

S. no.	Genotypes	Status of material
1	JHO 822	Released variety
2	JHO 851	Released variety
3	NGB 4462	Elite breeding line
4	NGB 6370	Elite breeding line
5	JHO 99-2	Elite breeding line
6	NGB 4871	Elite breeding line
7	NGB 7245	Elite breeding line
8	NGB 7021	Elite breeding line
9	NGB7253	Elite breeding line
10	NGB 7022	Elite breeding line
11	EC 473800	Exotic material
12	UPO 212	Released variety
13	OS 6	Released variety
14	HJ 8	Released variety

Different oat genotypes were evaluated in pot experiments under glass house conditions for different salinity regimes to identify suitable genotypes/donors for salinity tolerance. Seeds (number of seeds approximately 12) per genotype for every treatment were sown in separate pots in 3 replications (capacity 12 kg soil/pot) for chloride dominant salinity conditions in mid-October filled with saline soil prepared by mixing sodium chloride (NaCl), sodium sulphate (Na_2SO_4), magnesium chloride ($MgCl_2.6H_2O$), sodium bicarbonate ($NaHCO_3$), inorganic salts ratios 13: 7:1: 2 with normal soil. These salts were mixed in different quantity based on total soluble salt (TSS) results, to prepare saline soil of three different levels of electrical conductivity *i.e.*, 4 EC dSm^{-1}, 8 EC dSm^{-1}, 12 EC dSm^{-1}. Electrical conductivity of soil measured by using an EC-TDS Analyser. Pots with normal soil were kept as control and the plants grown in these pots were treated as control plant of corresponding genotype/salinity level. Germination % was determined on the 7th day after sowing. However, Sodium and Potassium were estimated by the Digital Flame Photometer (Jeffery, 1989). The leaf samples were taken from the fully matured plants.

Results and Discussion

a. Germination (%)

The effect of different salt concentration on germination percentage has been shown in fig. 1. It is evident from the figure that germination percentage gradually decreased in all oat genotypes as the concentration of salinity increased from 4 EC dSm^{-1} to 12 EC dSm^{-1}. The maximum percentage germination was shown JHO 822, JHO 851, NGB 6370 and JHO 99-2 at all salinity levels including control. Germination is one of the most vital phase of life cycle of plants and highly responsive to existing environment, the soluble salt in the root beyond a critical limit, adversely influenced germination. Salinity causes osmotic stress (Nandawal *et al*., 2000; Daniela *et al*., 2004) or specific ion effects, which delay, reduces or completely inhibit seed germination (Munns, 2002; Hanselin *et al*., 2005). Present results indicate that percentage germination in different oat cultivars reduced significantly with increasing the salinity levels from 4 EC $dSm^{-1}$to 12 EC dSm^{-1}. Genotype JHO 822 germination at lower and moderate doses of salinity was not affected as compared to control and showed 83.3% germination at 4 EC and 66.6% at 8 EC salinity, whereas it was reduced to 50% at 12 EC. Similar results were also observed in genotype JHO 851 and JHO 99-2 where germination was not adversely affected as compared to control and showed 91.1% germination at 4 EC and 75% at 8 EC salinity, whereas it was reduced to 58.3% at 12 EC. Variable performance of oat genotypes for germination ability indicates its genetic potential for salt tolerance. (Verma *et al*., 1986) and has also been observed by Tejovathi *et al*. (1988) in oat.

In genotype NGB 4462 germination was slightly affected as compared to control and showed 75% germination at 4 EC dSm^{-1}while at 8 $ECdSm^{-1}$ germination, was reduced 66.6% and further it was drastically reduced to 41.1% at12 $ECdSm^{-1}$ salinity. Similarly genotype NGB 6370, germination at lower and moderate doses was not affected as compared to control and showed 83.3% germination at 4 $ECdSm^{-1}$ and 75% at 8 $ECdSm^{-1}$, whereas it was reduced to 58.3% in 12 $ECdSm^{-1}$. Genotype NGB 4871 showed moderate reduction at 4 EC dSm^{-1} and 8 $ECdSm^{-1}$ in comparison to control, whereas it was drastically reduced to 41.6% at12 $ECdSm^{-1}$ salinity. Similar results were also seen in genotypes NGB 7245, NGB 7253, UPO 212, EC 473800 and HJ 8 also exhibited moderate tolerance for different salinity level and significant reduction in germination at higher salinity level. Genotype NGB 7021 and OS 6 was found to be moderately tolerant at 4 EC dSm^{-1} level and it showed

Table 2 : K^+/Na^+ estimation in leaf of selected genotype under saline vis-à-vis normal condition.

Genotypes	Ions	Control	4EC	8EC	12EC
JHO 822	K^+	0.82	0.5	1.16	0.95
	Na^+	1.15	0.5	0.71	0.76
	K^+/Na^+	0.71	1.00	1.63	1.25
JHO 851	K^+	0.67	0.69	0.54	1.01
	Na^+	1.21	1.30	0.62	1.69
	K^+/Na^+	0.55	0.53	0.87	0.60
NGB 4462	K^+	0.77	1.4	0.96	2.32
	Na^+	0.25	1.12	1.45	2.49
	$K^+/Na+$	3.08	1.25	0.66	0.93
NGB 6370	K^+	0.78	0.99	1.11	1.03
	Na^+	1.41	1.31	0.70	0.72
	K^+/Na^+	0.55	0.75	1.58	1.43
JHO 99-2	K^+	0.69	0.70	0.56	1.03
	Na^+	1.21	1.30	0.62	1.69
	K^+/Na^+	0.57	0.53	0.90	0.60
NGB 4871	K^+	1.17	1.16	0.85	0.76
	Na^+	0.21	0.24	0.28	0.33
	K^+/Na^+	5.57	4.83	3.03	2.30
NGB 7245	K^+	0.86	0.94	0.64	0.9
	Na^+	0.3	0.74	1.11	1.63
	K^+/Na^+	2.87	1.27	0.58	0.55
NGB 7021	K^+	2.49	0.89	0.57	-
	Na^+	0.18	0.36	0.37	-
	K^+/Na^+	13.8	2.47	1.54	-
NGB 7253	K^+	0.92	0.6	0.1	1.75
	Na^+	1.1	0.28	0.21	1.06
	K^+/Na^+	0.84	2.14	0.48	1.65
NGB 7022	K^+	0.9	0.94	1.87	1.81
	Na^+	0.22	1.23	1.78	2.02
	K^+/Na^+	4.09	0.76	1.05	0.90
EC 473800	K^+	1.11	0.98	0.71	0.63
	Na^+	1.66	1.07	0.94	1.1
	K^+/Na^+	0.67	0.92	0.76	0.57
UPO 212	K^+	0.67	0.94	0.68	0.82
	Na^+	0.28	0.74	0.88	1.11
	K^+/Na^+	2.39	1.27	0.77	0.74
OS 6	K^+	0.93	0.66	0.72	-
	Na^+	0.43	0.75	1.06	-
	K^+/Na^+	2.16	0.88	0.68	-
HJ 8	K^+	0.68	0.54	0.55	0.9
	Na^+	0.43	0.46	0.57	1.79
	K^+/Na^+	1.58	1.17	0.96	0.50

Ion concentration is in ppm/0.5 gm.

33.3% germination but at 8 and 12 ECdSm^{-1} salinity genotypes found highly susceptible for increased salinity as no seed germination was observed.

Salinity interferes with the process of water absorption by the seeds. This subsequently inhibits the hydrolysis of seed reserves which ultimately delays and decreases seed germination. It seems that decreased in percent germination may be due to decrease of water movement in to the seeds which can be called water deficit effects of salinity. Different cultivars reveal their varying ability of seed germination towards salinity.

b. Na^+ and K^+ uptake

The effect of salt stress on uptake of sodium and potassium ions in oat genotypes is shown in fig. 2. In this study, the values of K^+/ Na^+ ratios in the 14 genotype of oat were found to be lowered with the rise of salinity level. The genetic variability was observed in response to increasing salinity level in Na^+ and K^+ content in the leaves. Data presented in table 2 showed that the K^+/Na^+ ratio decreased in genotype with salinity on comparing with control. Under experimental condition, the genotype JHO 822 showed better tolerance mechanism to increasing level of NaCl treatment had high K^+ content over the whole salinity range (as compared with control). However, K^+/Na^+ ratio gradually increased (0.71 in control to 1.25 in 12 EC level), indicating that the genotype is tolerant to the salinity. Similarly tolerance mechanism observed in genotype JHO 851, JHO 99-2 and NGB 6370 with increasing dose of salinity decrease of Na^+ accumulation in leaves was observed with gradual increase in K^+/Na^+ ratio indicating that genotype is tolerant to the salinity. The ability of plants to discriminate between Na^+ and K^+ can be determined by an index of the K^+/Na^+ ratio (Flowers, 2004; Zhao *et al*., 2007). The potassium supplementation improved the growth of oat, which is evident from the germination data.

Genotype NGB 4462, NGB 4871, NGB 7245, NGB 7022, NGB 7253, EC 473800, UPO 212 and HJ 8 the K^+ ion concentration in plant was not significantly affected by the increasing salinity level, however there was a linear increase in the level of Na^+ (0.3 in control to 1.63 in 12 EC level). It resulted in the gradual lowering of K^+/Na^+ ratio (2.87 in control to 0.55 in 12 EC level) indicating that the genotype is moderately tolerant to salinity. However in genotypes NGB 7021 and OS 6, there was a drastic reduction in K^+ uptake in leaves with increasing salinity which resulted in mortality at 12 EC dSm^{-1}. Uptake of Na^+ also increased significantly in lower salinity level and remained same at higher salinity level. It indicated that drastic reduction in K^+/Na^+ ratio, the genotype is

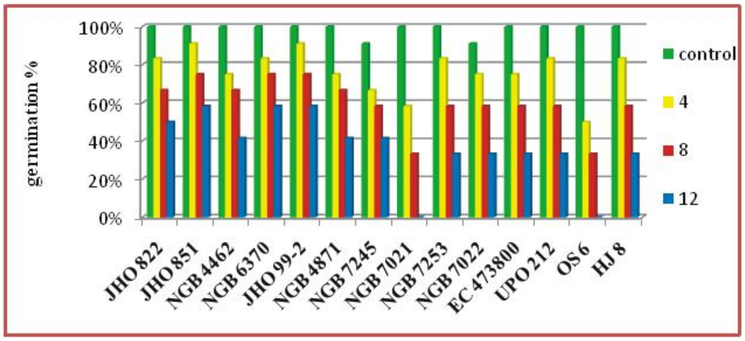

Fig. 1 : Germination % saline/ control condition.

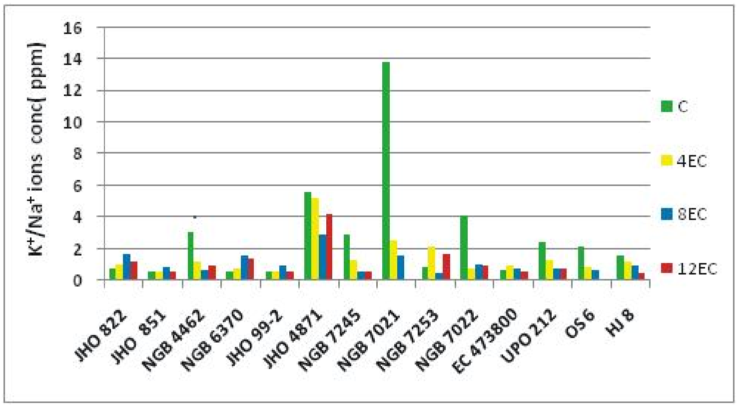

Fig. 2: K^+/ Na^+ accumulation ratios in leaves saline/ control condition.

highly susceptible to salinity. Previous studies indicate that salt tolerance is associated with higher K^+ contents because of involvement in osmotic regulation and competitive effect with Na^+ (Ashraf *et al.*, 2005). Regulation of K^+ uptake and prevention of Na^+ entry, efflux of Na^+ from the cell are the strategies commonly used by plants to maintain desirable K^+/ Na^+ ratios in the cytosole. In the present study, the tolerant genotypes are also expressing the same trend. The increase Na^+ concentration was also accompanied by decrease in K^+ concentration and uptake. K^+/Na^+ ratio is the criteria established and genetically approved for salt tolerance. These varieties also showed manifestation of higher K^+/ Na^+ ratio to express salt tolerance.

Conclusion

Based on the study, it was concluded that oat genotypes selected possess wide variability in respect their response to increasing salinity. Genotypes also varied in their capacity for the accumulation potassium and sodium. Germination (%) showed reduction in all genotypes and tolerant genotypes showed less decrease and increase K^+/ Na^+ ratios. Based on the germination (%) and K^+/ Na^+ ratios genotypes JHO 822, JHO 851, NGB 6370 and JHO 99-2 found tolerant at increased salinity level. The identified genotypes can be utilize in breeding progamme for developing oat varieties for salinity affected areas.

References

Ashraf, M. Y., K. Akhtar, G. Sarwar and M. Ashraf (2005). Role of rooting system in salt tolerance potential of different guar accessions. *Agronomy for Sustainable Development*, **25** : 243-2.

Daniela, D. B., N. I. Flavia and I. Riccardo (2004). Sea water irrigation: antioxidant defence references in leaves and roots of a sunflower (*Helianthus annuus* L.) ecotype. *Journal of Plant Physiology*, **161** : 1359-1366.

Flowers, T. J. (2004). Improving crop salt tolerance. *Journal of Experimental Botany*, **55** : 307–319.

Hanselin, M. H. and T. Eggen (2005). Salinity tolerance during germination of seashore halophytes and salt tolerant grasscultivars. *Seed Science Research*, **15** : 43-50.

Jeffery, G. H., J. Basset, Mendham and R. C. Denney (1989). *Vogel .S text book on quantitative chemical analysis*. 5th edition scientific technical. Longmann Group U.K LTD. Harlow (Flame Photometery).

Majeed, A., M. F. Nisar and K. Hussain (2010). Effect of saline culture on the concentration of Na^+, K^+ and Cl^- in *Agrostis tolonifera*. *Current Research Journal of Biological Science*, **2(1)** : 76-82

Munns, R. (2002). Comparative physiology of salt and waterstress. *Plant Cell Environment*, **28** : 239-250.

Nandawal, A. S., M. Godara, S. Sheokand, D. V. Kamboj, B. S. Kundu, M. S. Kuhad, B. Kumar and S. K. Sharma (2000). Salinity induce changes in plant water status, nodulefunctioning and ionic distribution in phenotypically different genotypes of *Vigna radiata* L. *Journal of Plant Physiology*, **156** : 350-359.

Singh, C., P. Singh and R. Singh (2003). *Modern techniques of raising field crops*. 2nd Edn, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi, India. pp: 429-436.

Tejovathi, G., M. A. Khadeer and S. V. Anwar (1988). Studieson certain enzyme in salt tolerant and sensitive varieties ofsunflower. *Indian Journal of Botany*, **11** : 113-117.

Verma, O. P. S. and R. V. R. Yadava (1986). Salt tolerance of some oats (*Avena sativa* L.) varieties at germination andseedling stage. *Journal of Agronomy and Crop Science,* **156** : 123-127.

Wang, W. X., B. Vinocur and A. Altman (2003). Plant responses to drought, salinity and extreme temperatures: towards genetic engineering for stress tolerance. *Planta*, **218** : 1-14.

Zhao, G. Q., B. L. Ma and C. Z. Ren (2007). Growth, Gas Exchange, Chlorophyll Fluorescence, and Ion Content of Naked Oat in Response to Salinity. *Crop Science*, **47** : 123-131.