Vol. XVII (1–2), 1980

EFFECT OF NATURE AND CONCENTRATION OF SALTS ON GERMINATION AND SEEDLING GROWTH IN BARLEY

Saeed Ahmad, Shamshad Hussain Shah, Muhammad Shabir Rauf and Z. A. Cheema*

Germination of six barley varieties 4342, W.C.C. 1-97, F.A.O. 11940, T-5, L.C. 27, and 5686 was tested at different salt concentrations in the laboratory. The salts were Na Cl, Na_2SO_4, K Cl and K_2SO_4 and the concentrations used for each salt were 0, 0.5, 1.0, 1.5 and 2.0 per cent.

It was observed that the germination percentage, root and shoot length of each variety decreased proportionately with increase in the salt concentration. Variety W.C.C. 1-97 proved to be the most salt tolerant at all levels of salinity; while chlorides were found to be more toxic than sulphates to all the varieties of barley used.

INTRODUCTION

Large areas in Pakistan have become salt affected and the growing of salt tolerant crops is the key to economic utilization of such lands. Barley is one of the highly salt tolerant crops, but is sensitive to salinity during the germination and seedling stage (U.S. Salinity Staff, 1954; Ayers *et al*, 1952). High specific ion effects of chlorides particularly during germination have been reported by a number of research workers (Harris, 1915; Harris and Pitman, 1918; Peterson, 1961; Karami, 1974). Hyder and Greenway (1965) observed that the reduced growth of barley due to Na Cl was considerably restored when 0.06 me/l of Ca^{++} and Sr^{++} was added to the nutrient solution. Therefore, it was decided to investigate the effect of sulphates and chlorides of Na and K on the germination and seedling growth of six barley varieties.

MATERIALS AND METHODS

The germination and seedling growth of six barley varieties i.e., 4342, W.C.C. 1–97, F.A.O. 11940, T-5, L.C. 27, and 5686 were tested at different

*University of Agriculture, Faisalabad.

concentrations of NaCl, Na_2SO_4, KCl, and K_2SO_4 in the Agronomy Department, University of Agriculture, Faisalabad. The concentrations used for each salt were 0, 0.5, 1.0, 1.5 and 2.0 per cent. The experiment was performed in 20 ml. test tubes and each treatment was repeated ten times. About 10 ml. of autoclaved agar medium was poured into each test tube and one healthy seed of each variety was planted per test tube. Sowing was done under aseptic conditions to avoid any infection. The test tubes were plugged with muslin cloth and cotton and placed in an incubator maintained at 25 ± 1 C° for seed germination. The data for germination percentage, daily shoot and root length were recorded till the seventh day after sowing. Completely randomized design was used and the data subjected to analysis of variance. Duncan's multiple range test was employed to ascertain differences among treatment's means.

RESULTS AND DISCUSSION

Germination percentage

The data regarding germination percentage of the six barley varieties are shown in Table 1. It is clear that varieties 4342, L.C. 27, and 5686 gave 94.7, 94.7 and 92.6 per cent germination as compared to W.C.C. 1–97, F.A.O. 11940 and T-5 which gave 91.1, 90.5, and 89.8 per cent germination. This showed that varieties 4342, L.C. 27 and 5686 were more salt tolerant that F.A.O. 11940 and T-5. Variety W.C.C. 1–97 was, however, found to be a medium salt tolerant. Ayers and Hayward (1948) reported that the crops differed in their salt tolerance at the germination stage.

Germination percentage of different barley varieties was also significantly influenced by salts and their different concentrations as shown in Table 1. It is apparent that germination was 100 per cent in control and decreased with increase in salt concentration. The decrease was more pronounced at salinity levels of 1.5 and 2.0 per cent. Ayers and Hayward (1948) also observed that barley germinated at the highest salinity level of 0.30 per cent but there occurred gradual delay and reduction in germination with a progressive increase in salinity from 0.12 to 0.30 per cent. The differences between control and low salinity level (0.5 per cent) were not significant but NaCl and KCl decreased the germination percentage sharply at higher concentrations of 1.5 and 2.0 per cent. These results are supported by the findings of Abel and Mackenzie

(1964) and Karami (1974) who reported that at the germination stage the increased salt concentrations severely affected the emergence of seeds. The relative toxic effects of the salts were in the order of $NaCl > KCl > Na_2SO_4 > K_2SO_4$.

Table 1. *Germination percentage of six barley varieties treated by different salts and their concentrations.*

A. Germination percentage for varieties

Varieties	*Germination (%)*
4342	94.7 a*
W.C.C. 1-97	91.1 ab
F.A.O. 11940	90.5 b
T 5	89.8 b
L.C. 27	94.7 a
5686	92.6 a

B. Germinan percentage for salts

	Concentrations (%)				
Salts	0.5	1.0	1.5	2.0	Control
					100.0 a
Na Cl	99.9 a	95.0 ab	85.6 c	62.7 d	
Na_2SO_4	99.9 a	94.6 ab	85.5 c	71.1 d	
K Cl	99.9 a	97.9 a	85.5 c	65.4 d	
K_2SO_4	99.9 a	97.9 a	90.9 b	71.1 d	

*Means followed by the same letter do not differ significantly at the 5% level.

Shoot length

The data in Table 2 show that the different varieties under trial responded differently to the salt concentrations. The results showed that the shoot length in varieties W.C.C. 1–97 and T–5 was significantly higher than other varieties under test. Varieties F.A.O. 11940 and 5686 were the least tolerant; while varieties L.C. 27 and 4342 were medium in response. The shoot length in varieties W.C.C. 1–97 and 5686 was 7.68 and 6.34 cm., respectively.

The seedling growth was decreased at the high salinity levels, i.e., 1.5 and 2.0 per cent (Table 2). At 0.5 per cent salt level, increase in shoot length was observed in all salts but as the level of salinity increased, there was a gradual decrease in shoot length. The shoot length decreased up to about 4 to 8 per cent at 0.5 per cent level of salinity, but as the salinity level was raised from 1.0 to 1.5 per cent, length was reduced to about 12 to 24 per cent. At 2.0 per cent concentration, however, the reduction in shoot length went upto about 67 to 83 per cent. These findings are in conformity with those of Eaton (1942) who reported that growth was reduced in proportion to the increase in salt concentration.

Table 2. *Shoot length of six barley varieties treated by different salts and their concentrations.*

A. Shoot length for varieties

Varieties	*Shoot length (cm)*
4342	6.80 b*
W.C.C. 1–97	7.68 a
F.A.O. 11940	6.49 c
T–5	7.56 a
L.C. 27	6.92 b
5686	6.34 c

B. Shoot length for salts

Salts	Concentrations (%)				
	0.5	1.0	1.5	2.0	11.61 a
Na Cl	8.67 e	6.52 h	3.73 k	0.70 m	
Na_2SO_4	9.66 c	8.73 de	7.15 g	3.86 k	
K Cl	9.00 de	7.78 f	5.33 j	2.62 l	
K_2SO_4	10.12 b	9.10 d	7.97 f	5.83 i	

*Means followed by the same letter do not differ significantly at the 5% level.

Root length

The Table 3 shows that significant differences in root length of various varieties existed due to salinization of the media. Variety W.C.C. 1–97 showed more tolerance to different salt concentrations as compared to other varieties. The root length was 6.53 cm. and 7.96 cm. in varieties 5686 and W.C.C. 1–97, respectively.

Table 3. *Root length of six barley varieties treated by different salts and their concentrations.*

A. Root length for varieties

Varieties	Root length (cm)
4342	7.10 b*
W.C.C. 1–97	7.96 a
F.A.O. 11940	7.17 b
T-5	6.88 bc
L.C. 27	7.04 b
5686	6.53 c

B. Root length for salts

Salts	Concentrations (%)				Control
	0.5	1.0	1.5	2.0	10.26 a
Na Cl	9.25 b	7.70 c	5.36 e	3.05 f	
Na_2SO_4	9.53 b	8.06 c	6.80 d	4.03 f	
K Cl	9.20 b	7.90 c	6.30 d	3.72 f	
K_2SO_4	9.49 b	8.24 c	6.83 d	5.20 e	

*Means followed by the same letter do not differ significantly at the 5% level.

Root growth of the seedlings in saline media was also significantly influenced as the salinity level increased from 0.5 to 2.0 per cent (Table 3). All the salts at 2.0 per cent concentration considerably reduced the root length, but it was more pronounced in case of chlorides of Na and K. This showed that there was a gradual reduction in the root growth probably due to the

increase in concentration of different salts used, i.e., NaCl, Na_2SO_4, K Cl, and K_2SO_4. These results are supported by the findings of Eaton (1942) and Hayward and Wadleigh (1949) who reported that the root length decreased with increased toxicity of the salts at different concentrations.

LITERATURE CITED

Abel, G H. and A.J. Mackenzie. 1964. Salt tolerance of soybean varieties (*Glycine max* L. Merrill) during germination and later growth. Crop Science 4: 157–61.

Ayers, A.D. and H.E. Hayward. 1948. A method for measuring the effects of soil salinity on seed germination with observations on several crops. Soil Sci. Soc. of America Proceedings 13: 224–26.

Ayers, A.D., J.W. Brown and C.H. Wadleigh. 1952. Salt tolerance of barley and wheat in soil plots receiving several salinization regimes. Agron 44: 307–10.

Eaton, F.M. 1942. Toxicity and accumulation of chloride and sulphate salts in plants. J. Agri. Res. 64: 357–99.

Harris, F.S. 1915. Effect of alkali salts on the germination and growth of crops. J. Agri. Res. 5: 1–54.

Harris, F.S. and D.W. Pitman. 1918. Soil factors affecting the toxicity of alkali. J. Agri. Res. 15: 287–319.

Hayward, H.E. and C.H. Wadleigh. 1949. Plant growth on saline and alkali soils. Advances in Agronomy 1: 1–38.

Hyder, S.Z. and H. Greenway. 1965. Effect of Ca^{++} on plant sensitivity to high NaCl concentrations. Pl. Soil 23: 258–60.

Karami, E. 1974. Emergence of nine varieties of sunflower (*Helianthus annuus* L.) in salinized soil cultures. J. Agri. Sci. Camb. 83: 359–62.

Peterson, H.B. 1961. Some effects on plants of salt and sodium from saline and sodic soils. Salinity problems in arid zones. Proc. of Tehran Symposium. UNESCO 14: 163–67.

U.S. Salinity Staff. 1954. Diagnosis and improvement of saline and alkaline soil. U.S. Deptt. of Agri. Handbook 60: 65–68.