DEVELOPMENT OF SALT-PROFILE IN SAND CULTURE

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INTRODUCTION

Despite the enormous work made on sand culture, no mention was ever made of the difference in nutrient distribution at the levels in the containers. This in may opinion warrant discovery as it became clear from the work of Newcombe and Rhodes (1904) that roots possess a high positive chemotropism even when the salts were deleterious and resulted in their perish. However, more attention was paid to the differences in the water table at the different levels in the culture containers (Lebedeff, 1937; Davidson, 1946). All observed that early growth of the experimental plants failed and attributed such failure to the inadequate moisture in the upper regions. Both high salt concentration and low moisture content are factors of evaporation and definitely affect plant growth.

MATERIAL AND METHODS

Eight inch plastic pots were used. Three holes were drilled on the pot side at 2″ distance from the bottom of the pot. Distilled water washed and sterilized sand of grain size 850 μ was used. The pots were filled to 1″ from rim with the sand. Subirrigation from 2-litre bottles with 1% NaCl A. R. were carried out. After one week of the first irrigation, sand samples were taken from the holes with No. 9 cork borer, weighed and dried at 100°C. Dried sand was then weighed and its liquid content determined and calculated as mg./gm. dry weight. The dried sand was washed in 200 ml. distilled water with continuous stirring for one hour. It was filtered through a filter candle under pressure. Several washings were made during filtration and the washings added to the filtrate. The filtrate was made up to one litre. Na was estimated in the filtrate by the flame photometer against a standard solution of NaCl. Chlorine was estimated in 50 ml. aliquots of the filtrate by Volhard method. Both ions were calculated as mg./gm. dry weight of sand and presented in Table 1.

Two pots were used, flushing and sampling were repeated at weekly intervals for 4 weeks. Distilled water was added to the flushing solution to restore its level in the reservoirs.

Analysis of variance was carried out on water content, Na and Cl contents taking depths and time of sampling and their interaction into consideration.

TABLE 1

Variations in Na-, Cl-, and water-content on the different weeks and at different depths

Weeks after flushing	Depth of sampling (inch.)	wt. of sand gm.	water content	Na	Cl
			mg. gm dry weight		
	1	16.04	0.011	0.46	
		13.32	0.019	0.46	
1 st week	3	18.36	0.199	0.48	
		18.18	0.213	0.42	
	5	21.76	0.319	0.45	
		19.38	0.372	0.49	
	1	16.28	0.244	0.42	0.61
		16.28	0.250	0.36	0.57
2 nd week	3	16.11	0.416	0.36	0.45
		16.11	0.417	0.33	0.47
	5	14.75	1.778	0.60	0.89
		15.08	1.443	0.54	0.82
	1	15.85	0.011	0.35	0.56
		18.12	0.108	0.22	0.33
3 rd week	3	17.80	0.417	0.14	0.22
		18.94	0.323	0.11	0.16
	5	17.14	1.932	0.46	0.79
		19.40	1.187	0.26	0.40
	1	18.56	0.026	0.28	0.42
		16.56	0.193	0.20	0.34
4 th week	3	16.18	0.403	0.28	0.30
		15.72	0.359	0.20	0.22
	5	14.89	1.668	0.53	0.93
		16.19	1.393	0.42	0.67

RESULTS AND DISCUSSION

It became clear from this experiment that the supplied salt developed a clear profile in the sand: more salt was accumulated at the top and bottom of the container. the middle layer had the lowest values (Table 1). This picture prevailed over the 4 weeks of the experiment though the absolute values were getting lower with lapse of time. Such decrease might be due to the loss of some of the originally supplied salt in sampling and to the addition of distilled water to restore the level in the reservoirs.

To confirm the above conclusions, statistical analysis was carried out. Analysis of variance for Na distribution (Table 2) showed that the depth and time of sampling affect significantly its distribution at 0.01 probability level. Mean for Na for W_1, W_2, W_3 and W_4 were 0.46, 0.43, 0.26 and 0.32 respectively with 5% l. s. d. of 0.08. For the same element means for D_1, D_2 and D_3 were 0.34, 0.29 and 0.47 respectively with 5% l. s. d. of 0.07.

TABLE 2

Analysis of variance for Na distribution

V. S.	d. f.	S. S.	M. S.	F
Weeks (W)	3	0.1668	0.0556	13.90**
Depths (D)	2	0.1345	0.0673	16.83**
W × D	6	0.0539	0.0090	2.25
Residual	12	0.0480	0.0040	
Total	23	0.4032		

However, the insiginficant interaction indicates that differences in depths effects were not significant from week to week at 0.05 level.

Though chlorine was not estimated during the first week, yet analysis of variance (Table 3) showed that both depth and time affected its distribution at 0.01 significance level. Means for W_2, W_3 and W_4 were 0.64, 0.41 and 0.48 respectively with 5% l. s. d. of 0.17. Means for the same element D_1, D_2 and D_3 were 0.47, 0.30 and 0.75 respectively with 5% l. s. d. of 0.17. Still the lack of significant interaction depth x weeks indicates that differences in depth effect were not significant from week to week.

TABLE 3

Analysis of variance for Cl distribution

V. S.	d. f.	S. S.	M. S.	F
Weeks (W)	2	0.1591	0.0796	4.85*
Depths (D)	2	0.6106	0.3053	18.62**
W × D	4	0.0408	0.0102	0.62
Residual	9	0.1479	0.0164	
Total	17	0.9584		

As regards the liquid content which represents the water table, it became clear from Table 1 column 4 that it increased with depth within the same week. Also a pronounced effect was observed between the first and second week. Analysis of variance (Table 4) confirmed such results.

TABLE 4

Analysis of variance for water-content

V. S.	d. f.	S. S.	M. S.	F
Weeks (W)	3	1.1611	0.3870	11.72**
Depths (D)	2	6.0183	3.0091	91.14**
W × D	6	1.2001	0.2001	6.06**
Residual	12	0.3962	0.0330	
Total	23	8.7763		

A significant effect to the 0.01 level was observed for both time and depth. Means for water content for W_1, W_2, W_3 and W_4 were 0.194, 0.758, 0.646 and 0.674 respectively with 5% l. s. d. of 0.229. Means for D_1, D_2 and D_3 were 0.096, 0.345 and 0.126 respectively with 5% l. s. d. of 0.198. Further, the significance of interaction week x depth indicates that differences in depth's effect were not the same from week to week. Similar results were obtained by (Hewitt 1952) and were considered responsible for the failure of growth during the early stages of seedlings for seeds sown at shallow depths. Apparently both low water content and high salt content are accumulative results of evaporation and are considered responsible for growth failure in such early stages.

The problem of salt distribution seem to warrant further studies with the use of mixed salts. Till the situation will be clearly elucidated, frequent irrigation is necessary during the early seedling stages in sand culture. This is essential both to wash the accumulated salts and to raise the water table in the top layers of the containers.

SUMMARY

When NaCl was supplied to sand, the ions were found to accumulate in the 1st two top inches and at the bottom 2 inches of the container. The middle layer, however, showed the least concentration. This is of great bearing on using sand as a solid medium for mineral nutrition experiments. A deleterious effect on root growth is therefore inevitable according to the +ve chemotropism of roots. Such an effect will be more pronounced in shallow rooted plants; that in addition to the lower water-table at this level which agrees with the findings of many workers (Hewitt 1952). To overcome this accumulation more frequent flushing with the nutrient seems necessary which in the meantime will raise the water content in the top layer of the soil.

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