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للتوثيق الفلاحي

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by

[illegible][1] [illegible][2], and [illegible][3]

Introduction

[illegible] of flax. [illegible] irrigation.

Experimental Methods

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[1] [illegible] (2) [illegible] and (3) [illegible]

was analysed both physically and chemically. About six grams of farm manure and 1 gram each of ammonium sulphate, superphosphate and potassium sulphate were mixed in the soil in each pot before planting.

Five grams of rice seed which consisted of about 150 grains were planted in each pot. After planting the pot was irrigated with 3 liters of water, which included (1) rain water which has an electrical conductivity of 0.50 mmhos/cm, (2) water from the Medjerda River which has an electrical conductivity of about 3 mmhos, and (3) the remaining 3 artificially prepared salinized water which had 3 different concentrations of salt, 3, mmhos, 6 mmhos and 9 mmhos/cm. This artificially salinized water was prepared by adding sodium chloride, calcium sulphate and magnesium sulphate to the rain water in a proportion similar to that of the salts of the Medjerda River water.

The pots were irrigated at two different depths, 3 cm and 6 cm at the beginning in May and June and 4 cm and 8 cm from July until the end of the experiment in the beginning of October. Thus, this trial consisted of 10 treatments in a factorial combination of 5 factors x 2 levels for each factor. Each of the 10 treatments was replicated 4 times, thus giving a total of 40 pots in all.

The pots were irrigated once every four days during May and June and once every two days during July and September. Before each irrigation the water still remaining in the pot was drained and the quantity of water irrigated and drained each time was measured, and the electrical conductivity of the drainage water was determined for each pot.

On the 15th of June the seedlings from each pot were pulled out and counted as well as their length of the top and of the root was measured.

On the same day twelve seedlings were transplanted to each pot in four hills containing 3 seedlings each.

The date of flowering was recorded, and during the time of harvesting the height of plants was measured and the number of panicles was counted in each pot. During threshing the number of seeds per panicle and the length of the panicle and the weight of 100 grains were measured. The yield of paddy grain in each plot was weighed.

Soil samples were taken from each pot at the depths, 0 - 15 cm and 15-30 cm at time after the rice was harvested. These samples were analysed by determining electrical conductivity and Sodium Adsorption Ratio (SAR) of the saturation extract. SAR was calculated by $SAR = Na / \sqrt{(Ca + Mg)/2}$ as given in Handbook 60 of the US Salinity Laboratory 1954.

Experimental Results

1. The soil properties before irrigation. The soil before irrigation was analysed and from this analysis it was found that the saturation percentage was 70 per cent, indicating a relatively low value taking into consideration the clay content of 45 per cent. The electrical conductivity was 1.6 millimhos and the SAR value was 2.1 also indicating that the soil was not saline.

2. Variation in behavior at the seedling stage. After one month of irrigation at different salt concentrations of water the seedlings at time of transplanting on 15 June have shown a great difference in characters such as the number of plants survived as well as the length of the top and of the roots. Data obtained from such characters are presented in Table 1.

Table 1. Average measurement of the different seedling characters

Treatment	Number of seedlings survived	Number of tillers per seedling	Height of the seedlings cm	Length of the root cm
Nile Water				
3 cm	34.2	1.5	41.5	17.6
6 cm	33.1	1.6	28.6	16.6
Drainage water				
3 cm	32.4	2.8	17.8	14.6
6 cm	42.8	1.6	17.1	14.7
2 mmhos/cm				
3 cm	23.8	1.6	24.8	4.3
6 cm	17.0	2.1	20.1	8.4
4 mmhos/cm				
3 cm	8.5	0.8	14.2	8.3
6 cm	12.6	0.6	15.8	3.3
8 mmhos/cm				
3 cm	8.8	0.8	35.8	5.0
6 cm	1.2	0.3	31.3	2.3

As the number of seeds sown in each pot is about the same in amount the number of seedling obtained in each pot can represent the rate of survival. It is observed from the Table the number of survival in the pots irrigated with rain water was higher than that with the Medjerda water, and that from the Medjerda water was again higher than the 3 mmhos water. Pots irrigated with the 6 and 9 mmhos water practically gave no seedlings at all except the pots irrigated with 6 cm depth of 6 mmhos water. The data also have shown that more plants survived in pots irrigated with 6 cm depth of water than that of 4 cm depth of water, indicating that the deeper the depth of irrigation the better and more the seedling survived.

Tillering was again in favour of rain water with Medjerda river water next best, and practically no seedlings survived in the pots irrigating with 6 and 9 millimhos.

However, the height of the seedlings does not appear to differ between treatments, as significantly as the percentage of survival. Root development was better in the pots irrigated with the rain water than those irrigated with the Medjerda river water, and those of the Medjerda river water was again better than those of the 3 millimhos water.

3. Irrigation and Drainage. The total quantity of irrigation and drainage water was determined from the results obtained from each irrigation and drainage during the entire course of the experiment. The average electrical conductivity of the drainage water was similarly determined. Table 2 presents the total quantity of irrigation and drainage water and the electrical conductivity of the drainage water.

Table. Total quantity of irrigation and drainage water and the average electrical conductivity of the drainage water.

Treatment	Quantity of irrigation water (litres)	Quantity of drainage water (litres)	Av.E.C. of the drainage water (mmhos/cm)
Rain water – 4 cm	187.07	56.87	1.06
– 6 cm	271.68	84.75	0.99
Medjerda water – 4 cm	183.25	43.17	8.07
– 6 cm	271.80	[illegible]	5.61
3 mmhos/cm – 4 cm	168.25	54.96	7.85
– 6 cm	275.58	101.88	[illegible]
6 mmhos/cm – 4 cm	183.93	88.68	10.50
– 6 cm	268.80	165.88	6.97
9 mmhos/cm – 4 cm	173.75	85.93	14.91
– 6 cm	268.63	158.50	13.41
L.S.D.	17.46	76.68	0.49

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The LSD values given at the bottom of the table were obtained from the analysis of variance with 5 degrees of freedom for treatments and 30 degrees of freedom for within the treatments, which was used to represent the experimental error. The LSD values are relatively small as compared with their means indicating that the variations in the 6 replicates were very small. The F value for the analysis of variance have shown that all the three variates were different significantly between treatments.

More water was irrigated to the rain water pots than to the Medjerda river plot and the 3 millimhos water pot, and more water to the Medjerda and to the 3 mmhos water pot than to the 6 and 9 millimhos water pot. Reversely, less water was drained from the rain water pot than from the Medjerda water pot and the 3 mmhos pot, and less from the Medjerda river water pot and the 3 mmhos pot than from the 6 and 9 millimhos pot. This was evidently due to the condition of the growth of the rice plants. As the rice in the rain water pot gave the best growth it consumed naturally more water.

The data on the electrical conductivity of the drainage water have shown that the salinity of the irrigation water was in reverse proportion to that of the drainage water. And it can be also seen from the results that the conductivity of the drainage water was higher from the pots irrigated with 4 cm depth of water than that with 8 cm depth of water.

4. Leaching Requirement as related to the electrical conductivities of the irrigation and drainage waters.

The leaching requirement is equal to the depth of drainage water over the depth of irrigation water or equal to the electrical conductivity of the irrigation water over the electrical conductivity of the drainage water. Based upon this relationship the percentage of irrigation drained was calculated for each treatment, which represents the actual amount of leaching. The proportion between the electrical conductivity of the irrigation water and that of drainage water was also calculated to determine the theoretical requirements of leaching. The data thus obtained are shown in Table 3.

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[illegible]	[illegible]	[illegible]
[illegible]		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

3. [illegible] of the [illegible] treatments on the [illegible]

All [illegible] in the pots irrigated with 4 and 8 [illegible] [illegible] by [illegible] is about 10 days after [illegible], and [illegible] the first of the end of June.

Only [illegible] in pots irrigated with rain water, the Medjerda [illegible] 4 and 8 [illegible] water [illegible] to reach maturity.

Some plant [illegible] were [illegible]. Plants grown in the rain-water pots flowered a few days earlier than those in the Medjerda and [illegible] pots and the plants irrigated with 4 cm depth [illegible] flowered a few days earlier than those with 8 cm depth.

At the time of harvesting, the height of the plants in each of the 4 hills in each pot was measured, and the total number of panicles bearing seeds in each pot was counted. Five panicles were chosen at random from each hill to measure their length, and to count their number of seeds per panicle, and finally the yield of paddy grain from each of the 4 hills was weighed, and the weight of 100 seeds was recorded. Each of these characters was subjected to an analysis of variance. Only the average measurements in each pot were used in the analysis of variance. The source of variation included only 5 degrees of freedom for treatments and 18 degrees of freedom for within the treatment. The data are given in Table 4.

Averages of [illegible] of the various plant characters

Treatment	Height of plant (cm)	No. of panicles	Length of panicles	No. of grains per panicle	Wt of 100 seeds (grams)	Yield per [illegible]
Rain water 4 cm	78.82	13.4	12.2	45.43	2.7	11.56
Rain water 8 cm	80.12	15.4	12.90	34.50	2.90	17.15
Medjerda 4 cm	79.28	13.1	11.4	55.95	2.33	7.51
Medjerda 8 cm	78.87	14.7	11.55	52.25	2.50	6.40
[illegible] water 4 cm	74.72	8.4	11.40	76.88	2.26	2.56
[illegible] water 8 cm	79.18	12.4	13.20	39.64	2.47	5.53
LSD	2.34	3.34	0.88	3.98	0.34	2.63
F values	83.5**	2.83*	34.6**	15.2**	3.5*	30.7**

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All the characters as indicated by their F values are found to be significantly different between treatments. However, variations in yield was greater than that of the other characters. As expected, yield was many times higher from the pot irrigated with rain water than with Medjerda water but the yield obtained from pots irrigated with Medjerda water was similar to that with the 3 mmhos water. This was evidently due to the fact that the Medjerda water contained also about 3 mmhos of salt. It is also interesting to see that the yield from the pot irrigated with 8 cm of water averaged at 9.72 grams per pot against 5.64 grams for the yield obtained by irrigating with 4 cm of water. This difference is highly significant, as the LSD value is only 2.94 grams, and can be explained by the fact that more irrigation to the pots would dilute the harmful effect of the salts in the soil.

6. Electrical conductivity and SAR values of the soil

Immediately after the harvesting of rice, in the beginning of December 2 soil samples were taken from each pot, one at the depth 0-20 cm (surface soil) and the other at the depth 20-40 cm. (subsurface soil). The extract of the saturated paste was prepared from each soil sample, and this extract was used to measure the electrical conductivity and the composition of sodium, calcium and magnesium salts. SAR was calculated according to the formula given previously. The data obtained are given in Table 5.

Table 5. Electrical conductivity and SAR values of the extract from the saturated paste of the soil samples taken from each of the 40 pots.

Treatment	Depth of sample	Conductivity avs. of 4 reps) (mmhos/cm)	SAR (avs. of 4 reps)
Rain water 4 cm	surface	1.50	0.74
	subsurface	1.37	2.95
Rain water 8 cm	surface	1.62	0.86
	subsurface	1.25	1.02
Medjerda 4 cm	surface	5.72	7.28
	subsurface	4.28	6.22
Medjerda 8 cm	surface	5.45	7.58
	subsurface	4.55	6.55
3 mmhos 4 cm	surface	4.30	7.38
	subsurface	3.75	6.62
3 mmhos 8 cm	surface	4.60	6.50
	subsurface	3.62	5.55
6 mmhos 4 cm	surface	5.60	8.55
	subsurface	4.38	7.72
6 mmhos 8 cm	surface	6.88	11.52
	subsurface	3.52	6.55
9 mmhos 4 cm	surface	14.00	15.67
	subsurface	4.70	8.70
9 mmhos 8 cm	surface	12.60	15.75
	subsurface	7.60	11.67

There were 20 treatments consisting of 10 factors of 2 levels at each factor. The analysis of variance for both the electrical conductivity and SAR was calculated on this basis. The results are given in table 6.

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Table 6. Analysis of variance for the Electrical Conductivity and the SAR values of the 80 soil samples

Sources of variation	Degrees of Freedom	Electrical Mean Square	Conductivity F	SAR Mean Square	F
Treatments	19	45.0165	17.4	74.6569	29.3
Surface	9	63.9141	24.6	139.7580	41.4
Subsurface	9	12.7075	4.9	41.0770	16.0
Surface vs subsurface	1	165.7305	63.8	78.9852	30.8
Error	60	2.5922		2.5475	

The treatments for both the electrical conductivity and SAR values differed highly significantly from each other. Their difference, however, was mainly due to the difference of the surface soil, and of the surface soil versus the subsoil. In other words, variation in the surface soil between treatments was higher than that in the subsurface soil.

Reference is made to Table 5 in which the data have shown both the conductivity and the SAR values were in direct proportion to the salinity of the irrigation water, that is to say, the higher the salt content in the irrigation water, the higher the salinity of the soil. In general, the salinity of the surface soil was higher than that of the subsurface soil and that of the soil in the pot irrigated with 4 cm depth of water was slightly less than that irrigated with 8 cm depth of water.

As all rice died in the pots irrigated with 6 and 9 mmhos of water it seems there is a demarkation in the tolerance of rice to salt between the 3 and 6 mmhos of water. This demarcation line may be called the plateau of maximum tolerance for rice. Comparatively speaking this plateau appears to be attributable more to the SAR than to the conductivity values. The SAR value for the 6 mmhos is 8.55 for the surface soil and 7.72 for the subsurface soil both of which are greater than the values of the water in which the rice survived. On the contrary, the electrical conductivity of the 6 mmhos water is 5.00 for the surface soil which is lower than that of the Medjerda water at the 4 cm depth and is 4.3 mmhos for the subsurface soil

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which is approximately equal to that of the [illegible] water irrigated at the 0 cm depth.

Calculations were made to study the relationship between the electrical conductivity of the surface and subsurface soil and between the SAR value of the surface and subsurface soil, and between the electrical conductivity and SAR values. The results are presented in Table 7.

Table 7. Correlation coefficients of the electrical conductivities and SAR values of the soil samples

Correlation	Values
Electrical Conductivity surface and subsoil	0.98
SAR surface and subsoil	0.94
Conductivity and SAR surface soil	0.97
subsurface soil	0.95

All the correlation coefficients were found highly significant indicating the close relationship between the salinity of the surface and subsurface soil and the electrical conductivity and SAR values. The significant relation between electrical conductivity and SAR means that the high electrical conductivity is due to the high content of sodium salts, which are harmful to the growth of the rice plants. The average SAR of the surface and the subsurface soil was correlated to the yield, and was found to be -0.85 for the treatments and 0.90 for the means, indicating that yield was highly correlated to the SAR value of the soil, the higher the SAR the lower the yield.

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Conclusions and Discussion

Rice could only survive in pots irrigated with 3 mmhos of water beyond which practically all seedlings died before reaching the transplanting stage. This demarcation line in the tolerance of rice to salt which lies between 3 and 6 mmhos/cm may be called the plateau of maximum tolerance. The rice, which as indicated by the results given in Table 3 may be attributable comparatively more to SAR than to the electrical conductivity.

It is interesting to point out that the SAR value of the surface soil in the pot irrigated with 6 mmhos water in which all rice died was 8.55 and that of the subsurface soil was 7.72.

A very high negative correlation was found between yield and SAR of the soil indicating that the higher the SAR, the lower the yield of the paddy rice. SAR is the sodium adsorption ratio.

Electrical conductivity was found highly correlated with SAR which means that the high conductivity of the soil is due to the high content of sodium salts which are harmful to the growth of the rice plants.

The leaching requirement is equal to the depth of drainage water over that of irrigation water which is equal to the electrical conductivity of the irrigation water over that of the drainage water. The actual amount of irrigation water drained was found to be very nearly equal to the theoretical expectation of the leaching requirement which was obtained by dividing the electrical conductivity of the irrigation water by that of the drainage water. The efficiency of leaching of the salts was higher with less irrigation than with more irrigation, but this efficiency, however, only means the quantity of irrigation and drainage water in relation to that portion of salt in the irrigation water removed from the soil by the drainage water. The fact that rice yielded more with more irrigation is evidently because of more water in the soil would dilute the harmful effect of the salts.

In view of the high yield obtained from the pots irrigated with 8 cm depth of water, it seems reasonable to conclude that rice must be irrigated with more water if the water contains salt, although more irrigation would result in less efficiency in leaching out the salt in the irrigation water.

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