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Soil survey and site selection for crop cultivation in Kuwait

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Introduction

Kuwait has an arid environment, which is dry for most of the year. In addition to aridity, Kuwait faces additional stresses from erosion, poor quality soils, consequences of the first Gulf war (1990/1991) (oil contamination, compaction, surface disturbance-landmines-bunkers), over-exploitation of land resources and inappropriate land use such as overgrazing, insufficient water resources, and salinization.

The assessment of the site for experimentation is a pre-requisite for any soil/plant management research development project. Such an assessment is only possible if the soils at the experimental sites are well characterized. A reliable service to analyze plant, soil and water for agriculture is now considered essential for sustainability and increasing agricultural production, as is the case of the proposed barley experimental project.

The purpose of the survey described here is to assess soil type in the selected site; how variable soils are and ascertain their physical and chemical characteristics. The survey of the site includes a field description of soils, which supplements the quantitative and qualitative analyses of specific soil properties.

Materials and methods

Soil from Al-Wafra was analyzed to assess its suitability for barley cultivation. Also water from the same site was analyzed to assess its suitability for irrigation.

The soil was analyzed three times under the supervision of Dr. Shabbir A. Shahid of KISR as follows: (i) Pre-experimental site survey (1999); (ii) After first year experiment (1999/2000) soil analysis; and (iii) After second year experiment (2000/2001) soil analysis.

Results

Water analysis

The EC is measured as 6.75 dS/m; this classifies the brackish water as C4 under the salinity category (Richards, 1954). It is assumed that these waters are saturated with Ca and SO_4, and it is expected that the sodium adsorption ratio (SAR) for these waters is less than 10 $(mmoles/l)^{0.5}$ and this classifies them as S1 as per the criteria established by Richards (1954). Due to shortage of time the SAR was not measured, but speculated from experience (Dr. Shahid 2003, personal communication). The analysis of many brackish water samples from Kuwait show an SAR ranging between 2 to 5 $(mmoles/l)^{0.5}$ (Dr. Shahid 2003, personal communication).

Results of first year soil analyses

Table 1. Mean physical and chemical characteristic of three Muslan soil samples (pre-experimental field trial)†

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Text. Class	Gr.	Bd	pHs	SP	ECe	SAR	$CaCO_3$	G.
0-30	91 (0.2)	4 (0.1)	4 (0.08)	Sand	3 (0.4)	1.85 (0.01)	8.2 (0.04)	18 (0.4)	3.2 (0.05)	0.2 (0.02)	5.8 (0.08)	0.2 (0.04)
30-100	87 (0.4)	4 (0.08)	9 (0.2)	Sand	2 (0.4)	1.86 (0.01)	8.3 (0.1)	21 (0.4)	3.2 (0.02)	1.9 (0.04)	3.0 (0.08)	0.1 (0.04)
100-150	91 (0.2)	2 0.06)	8 (0.2)	Sand	6 (0.2)	1.80 (0.01)	8.3 (0.01)	19 (0.4)	4.2 (0.06)	2.4 (0.04)	1.2 (0.06)	0.3 (0.02)
150+	88 (0.4)	3 (0.06)	9 (0.1)	Sand	3 (0.4)	1.81 (0.01)	8.3 (0.01)	18 (0.4)	4.1 (0.06)	2.5 (0.04)	0.6 (0.04)	0.3 (0.04)

†Numbers in brackets indicate standard error.
Sand (2-0.05 mm); Silt (0.05-0.002 mm); Clay (<0.002 mm); Gr. = Gravels (2-5 mm); Bd = Bulk density; SAR = Sodium Adsorption Ratio; ECe = Electrical conductivity of saturation extract in dS/m; pHs = pH of saturated paste; SP = saturation percentage; G= Gypsum.

Results after first year field experiment

Table 2. Soil analysis: mean pH, ECe (electrical conductivity of saturation extract) and SP (saturation percentage) of three samples after completions of first year field experiment

Treated plots	pH		ECe (dS/m)		SP (g/cm^3)	
	Soil depth /cm		Soil depth /cm		Soil depth /cm	
	0-15	15-30	0-15	15-30	0-15	15-30
Fresh water	7.33	7.11	9.22	7.79	20.74	20.67
Brackish water	7.70	7.97	51.50	50.90	20.40	21.14
S.E. between treatments	0.2	0.4	21.1	21.6	0.2	0.2

Results after second year experiment

Table 3. Soil analysis: mean pH, ECe (electrical conductivity of saturation extract) and SP (saturation percentage) of three samples after completion of second year field experiment

Treated plots	pH		ECe (dS/m)		SP (g/cm^3)	
	Soil depth /cm		Soil depth /cm		Soil depth /cm	
	0-15	15-30	0-15	15-30	0-15	15-30
Fresh water	7.00	7.20	8.80	7.70	21.80	21.80
Brackish water	7.50	7.70	25.50	30.00	22.60	21.80
S.E. between treatments	0.3	0.3	8.4	11.1	0.4	0.0

The ECe results of the water from the site and the quality of the brackish water used in the farm area were encouraging as they indicate that barley can be grown. In short the results allowed the work to progress to field trialling.

Discussion and conclusion

Although soils at Al-Wafra are non-gypsiferous and calcareous to varying degrees and non-saline

and non-sodic, the soil has a very low clay and organic matter content and, therefore, has a low water storage capacity as well as inherent soil fertility. There is usually a darker layer of variable thickness at the top of the observation pits due to relatively high organic matter. Below that, the colour changes due to the presence of calcium carbonates or gypsum (white or brownish), yellowish or redder (different states of iron) and differences in structure due to pedological changes.

The present study has clearly shown the improvement of soil physical and chemical properties by brackish water irrigation, however salinity was increased and therefore needs to be controlled. This could be managed as the properties of the Muslan series favour the rapid rejuvenation through leaching of salts. The present study will give encouragement and confidence to the farming community in Kuwait in the use of brackish water. It is likely that the use of brackish water for irrigation will become practical, sustainable and more economical in the future in Kuwait, but will require careful monitoring.

References

Richards, L.A. (1954). *Diagnosis and improvement of saline and alkaline soils*. USDA Handbook, No. 60.