LAND SUITABILITY OF NORTH DELTA REGION FOR SAKHA-93 WHEAT CULTIVAR

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(Manuscript received 13 February 2006)

Abstract

The current study aims at estimating the land suitability of some soils in Egypt for wheat cultivar which is known as salinity tolerant. The northern part of the Delta was sampled by ten profiles to represent various levels of soil salinity. Two evaluation meth+ods were applied. The obtained data show that land suitability indices for Sakha-93 cultivar range between 9.18 and 85.73 according to Storie method and between 13.55 and 89.77 by applying the Square Root method. The variations of land suitability indices are mainly attributed to soil salinity. Therefore, the present study shows the need for wheat cultivar which may tolerate higher soil salinity levels.

INTRODUCTION

Wheat (*Triticum sp.*) is the most important grain crop in the world as well as in Egypt, specially, as bread is the main common food component for most of the people. Great efforts have been paid by the government to narrowing the food gap in grain group and particularly in wheat. However, great amount is still imported in order to fill the gap between wheat production and consumption. Consequently, a considerable portion of the national income is consumed in importing wheat grain and flour. Recently scientists play a significant role in solving the problem by breeding new species of wheat that are relatively high productive, tolerant diseases and to severe environmental conditions such as soil salinity, high temperature and drought for at least the deficit of good quality of irrigation water. Some of the new species are suitable for the newly reclaimed land.

Hassan and Hassan (1994) found that sowed wheat cultivars (Sakha-8 and Sakha-92) on slopping of furrows of sandy loam over sand produced maximum values for number of plants/m^2, of tillers/plant, fresh weight, leaf area and specific leaf weight. They attributed these results to improvement of seed bed and / or more tolerance to saline irrigation water. In a comparison experiment in sandy soil between the growth response of some wheat cultivars. The results obtained by Ashour and Selim (1994) showed that the growth of Sakha-8 cultivars surpassed

other cultivars under saline conditions (5.6 and 5.9 dS/m). They also mentioned that Sakha-8, Giza-163 and Giza-164 cultivars surpassed the other cultivars in seed yield and some yield attributes, under the same conditions.

Gawish *et al.* (1999) reported in their study on salt tolerance of certain wheat varieties, the possibility of using different concentrations of salt solutions as a practical means for evaluating the plant resistance to salt. Such approach required a salt application for a period of few days when using high saline solution (20,000 ppm), longer periods being needed with less concentrations of applied salts (17 days for 12,500 ppm). Applying the suggested approach resulted in selection for Sakha-69 as the relatively salt-sensitive variety and Giza-164 as a relatively salt-resistant variety. Khodier *et al.* (1999) showed that comparing the effect of 10 dS/m irrigation water salinity level on grain yield and yield components in each of sandy soil and sandy loam soil indicate that this salinity level seems to be enough for selecting the highest grain yield genotypes in sandy soil but not enough to discriminate the superior salinity tolerant genotypes in clay soil.

The present work aims at estimating the suitability of saline soils in Egypt for some wheat cultivars, which are known as salinity tolerant varieties.

MATERIALS AND METHODS

Soil Investigations

The north Delta region is selected as prospective area for wheat cultivation under soil salinity conditions. Ten soil profiles (Map 1) were examined and sampled for laboratory analyses according to Black *et al* (1982). The following determinations were conducted:

-Grain size distribution by sieving (for sandy soils) and mechanical analysis by pipette (for clayey soils).

-Soil pH in 1 : 2.5 soil to water suspensions.

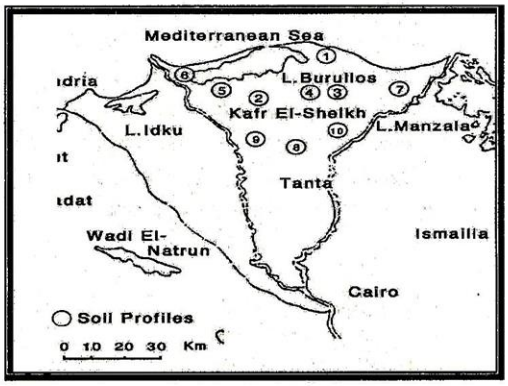
-The electrical conductivity (EC) of the saturated soil paste extract.

-Total carbonates as calcium carbonate content.

-Soluble cations and anions of the saturated soil paste extract.

-Cation exchange capacity.

-Organic carbon content.



Map1. Location of the sampled profiles.

Land suitability methods

The framework work of FAO (1976) for land evaluation defined the land characteristics which are related to the requirements for specific land utilization type. However, the weighing value for each characteristic is determined by the method which is used for land suitability index estimation. Therefore two calculation methods were applied to compute the suitability index (Storie, 1964) and Square Root (Khiddir, 1986) methods as end product of the parametric assessment of land evaluation.

Storie method

$$SI = \frac{A}{100} \cdot \frac{B}{100} \cdot \frac{C}{100} \cdot \frac{D}{100} \cdot \frac{E}{100}$$

Where:

A, B ...etc are the rating of different soil parameters (slope drainage. soil depth. Ca CO_3, EC,..).

Square Root method (Khiddir, 1986)

$$SI = \text{minimum rating value} \times \frac{A}{100} \cdot \frac{B}{100} \cdot \frac{C}{100} \cdot \frac{D}{100}.$$

Where:

A, B ...etc are other ratings of different soil parameters besides the minimum rating.

RESULTS AND DISCUSSION

Soil investigation

The morphological examination of the representative soil profiles from North Delta (Soil Profile Description) revealed that the topography was mostly flat. The studied

areas were either agricultural or barren land. They had moderate to poor soil drainage conditions. The water-table level was about 80 to 100 cm deep. The soil texture varied from loamy sand, silty loam, clay loam to clayey. Soil structure ranged between structureless and strong coarse sub-angular blocky according to soil texture. Mostly, the soils had weak effervescence with HCl. The boundaries between the profile layers were diffuse in the light textured soils and sharp in the heavy ones.

Morphological description of Five representative profiles

Profile No. : 1
Location : North Delta, Baltiem
Topography : flat
Vegetation : few scattered desert shrubs
Drainage condition : poor
Depth of water-table : 100 cm
Profile depth : 100 cm

Depth (cm)	Description
0 - 20	Light gray (2.5YR 8/2, dry), light brownish gray (2.5YR 7/2, moist); Loamy sand; structureless; Slightly sticky, slightly plastic; few fine roots; weak effervescence with HCl; diffuse boundary.
20-100	As above layer except light brownish gray (2.5YR 7/4, dry), grayish brown (2.5YR 6/2, moist); no roots.

Profile No. : 2
Location : North Delta, El-Hamaul
Topography : flat
Vegetation : cultivated with maize
Drainage condition : moderate
Depth of water table: 100cm
Profile depth : 100 cm

Depth (cm)	Description
0-30	Grayish brown (2.5YR 4/2, dry), brownish black (2.5YR 3/2, moist); clay loam; weak, medium sub- angular blocky; sticky, plastic; common medium roots; weak effervescence with HCl diffuse boundary.
30-100	As above layer except brownish gray (2.5YR 4/1, dry) grayish brown (2.5YR 4/2, moist); no roots.

Profile No. : 3
Location : North Delta, El-Burulls
Topography : flat
Vegetation : natural plants shrubs
Drainage condition : poor
Depth of water table : 100 cm
Profile Depth : l00cm

Depth (cm)	Description
0 - 30	Brownish gray (10YR 4/2, dry), brownish black (10YR 3/1, moist); strong medium angular blocky; sticky. Plastic; few fine roots; weak effervescence with HCl; sharp boundary.
30-60	Grayish yellow brown (10YR 5/2, dry), grayish yellow Brown (10 YR 4/2, moist); silty loam strong coarse sub-angular blocky; sticky, plastic; weak effervescence with HCl; sharp boundary.
60-100	Brownish gray (10YR 4/1, dry), brownish black (10YR 3/1. moist); clay loam; strong coarse sub-angular blocky; sticky, plastic; weak effervescence with HCl.

Profile No. : 4
Location : North Delta, Baltiem
Topography : flat
Vegetation : natural plants shrubs
Drainage condition : poor
Depth of water table : 100 cm
Profile Depth : l00cm

Depth (cm)	Description
0 - 40	Light gray (7.5YR 4/2, dry), light brownish gray (7.5YR 5/2, moist); sandy: structureless; slightly sticky, slightly plastic; few fine roots; weak effervescence with HCl; diffuse boundary.
40-100	As above layer except light brownish gray (7.5YR 8/4, dry) grayish brown (2.5YR 6/2, moist): no roots.

Profile No. : 5
Location : North Delta, El-Burulls
Topography : flat
Vegetation : natural plants shrubs
Drainage condition : poor
Depth of water table : 100 cm
Profile Depth : l00cm

Depth (cm)	Description
0 - 30	Brownish gray (8YR 5/2, dry) brownish black (8YR 4/1, moist) clay loam; strong medium angular blocky; sticky. Plastic; few fine roots; weak effervescence with HCl; sharp boundary.
30-60	Grayish yellow brown (8YR 5/2, dry) grayish yellow. Brown (8YR 5/2, moist); silty loam strong coarse sub-angular blocky; sticky, plastic; weak effervescence with HCl; sharp boundary.
60-100	Brownish gray (8YR 5/2, dry) brownish black (8YR 3/1. moist); clay loam; strong coarse sub-angular blocky: sticky, plastic; weak effervescence with HCl.

The lab-analyses (Tables 1 and 2) indicate that the soils under investigation belong to different salinity classes, where the EC values fluctuate between 0.9 and 74.0 dS/m. The soil reaction (pH) is not exceeding 8.2. Calcium carbonate content is at maximum 3.77 % .The concentration of cations and anions (table 2) reveal that the dominant salts are: NaCl > Na_2SO_4 > $MgSO_4$> $CaCl_2$ > KCl.

The soils under investigation clearly indicate the wide variation and the different conditions which are necessary for the wheat cultivars suitability assessment.

Table 1. Some physical and chemical analyses of the studied soils.

location	Profile No.	Depth cm	Textural fractions* Sand %	Silt %	Clay %	Textural Class	$CaCO_3$ %	CEC Meq/ 100g
Baltiem	1	0-20	65.10	14.45	20.45	Loamy Sand	0.88	16.9
		20-100	70.20	18.40	11.40	Loamy Sand	0.53	18.0
El-Hamaul	2	0-30	18.80	49.90	31.30	Clay Loam	1.75	34.7
		30-100	15.30	45.30	39.40	Silt Loam	2.11	38.2
El-Burulls	3	0-30	20.30	52.30	27.40	Silt Loam	1.10	23.0
		30-60	17.80	50.10	32.10	Clay Loam	1.40	26.6
		60-100	12.80	47.30	39.90	Clay loam	1.80	32.4
El-Burulls	4	0-40	98.63	0.50	0.87	Sand	0.02	3.3
		40-80	99.70	0.20	0.10	Sand	0.60	3.5
		80-120	95.14	0.60	4.26	Sand	0.35	3.1
El-Burulls	5	0-30	96.90	1.00	2.10	Sand	-	3.4
		30-60	95.70	0.50	3.80	Sand	0.13	3.2
		60-100	96.30	0.50	3.20	Sand	0.47	3.3
El-Burulls	6	0-25	98.10	1.00	0.90	Sand	0.10	3.7
		25-50	94.80	0.50	4.70	Sand	1.80	3.1
		50-70	94.10	1.00	4.90	Sand	1.80	3.3
El-Burulls	7	0-30	99.00	0.50	0.50	Sand	-	3.7
		30-70	94.60	1.10	4.30	Sand	0.30	3.2
Sidi- salem	8	0-30	21.02	15.00	63.98	Clay	1.22	50.5
		30-60	15.90	19.00	65.10	Clay	1.53	51.2
		60-90	14.20	20.50	65.30	Clay	1.38	51.3
Sidi- salem	9	0-25	5.94	29.50	64.56	Clay	0.92	50.9
		25-50	6.48	31.50	62.02	Clay	1.30	49.0
		50-100	5.66	36.50	57.84	Clay	1.30	45.9
Sidi- salem	10	0-30	6.21	26.50	67.29	Clay	1.89	53.0
		30-60	9.30	19.50	71.20	Clay	2.30	55.9
		60-90	1.63	20.00	78.37	Clay	3.77	61.2

* Sand: 2 00 - 0.05 mm
Silt: 0.05 - 0.002 mm
Clay: < 0.002 mm

Table 2. Chemical characteristics of the studied soil profiles.

Profile	Depth Cm	pH 1: 2.5	EC dS/m	Soluble cations (meq/l)				Soluble anions (meq/l)		
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
1	0-20	8.0	21.7	35.2	42.3	133.0	6.5	4.5	175.2	37.3
	20-100	8.2	11.0	15.5	22.3	68.2	4.0	3.0	77.8	29.2
2	0-30	8.1	16.0	40.0	28.8	88.2	3.0	2.5	135.0	22.5
	30-100	8.2	18.5	44.1	30.2	106.7	4.0	3.0	143.4	38.6
3	0-30	8.0	35.8	73.4	45.5	227.1	12.0	7.0	235.3	115.7
	30-60	8.0	42.5	99.5	80.8	229.7	15.0	11.0	285.5	128.5
	60-100	7.7	39.3	90.4	71.2	218.4	13.0	9.5	268.5	115.0
4	0-40	7.5	18.2	43.5	23.7	140.0	5.6	0.8	160.0	52.0
	40-80	7.6	17.3	20.1	25.3	144.0	3.4	0.8	155.0	37.0
	80-120	8.1	74.0	82.6	233.0	950.0	25.0	0.8	1245.0	44.8
5	0-30	7.5	0.9	2.6	0.3	6.2	0.5	2.0	6.0	1.6
	30-60	7.4	2.5	4.2	1.3	17.5	0.9	2.5	19.5	1.9
	60-100	7.7	6.3	7.1	5.7	54.0	1.9	1.5	62.1	5.1
6	0-25	7.4	16.6	41.3	31.4	122.0	3.0	1.0	171.7	25.0
	25-50	7.6	17.5	38.4	35.3	134.0	3.3	0.8	186.0	24.2
	50-70	7.7	20.2	23.3	44.4	180.0	4.0	1.0	244.7	6.0
7	0-30	7.7	5.7	10.0	17.6	37.0	1.0	1.0	56.2	8.4
	30-70	7.9	10.5	16.6	17.7	80.0	2.4	1.0	107.7	8.0
8	0-30	7.5	4.0	9.3	6.5	51.0	0.4	1.8	55.2	10.2
	30-60	7.4	7.0	11.7	10.4	52.0	0.5	2.0	54.6	18.0
	60-90	7.5	10.0	19.1	20.0	84.0	1.0	1.4	104.1	18.6
9	0-25	7.5	7.3	13.2	14.0	36.5	0.7	1.0	53.9	9.5
	25-50	7.6	8.2	9.5	16.7	58.5	0.6	1.0	74.1	10.2
	50-70	7.5	13.1	11.6	17.5	114.0	1.4	1.5	133.5	9.5
10	0-30	7.1	9.0	10.8	18.3	74.0	1.0	1.8	91.7	10.6
	30-60	7.6	12.5	6.9	15.8	109.0	1.3	1.8	110.8	20.4
	60-90	7.6	14.4	8.5	21.8	129.0	1.4	2.0	141.7	17.0

Land suitability assessment

The general soil requirements for the selected cultivar Sakha-93 according to the recommendations of the Ministry of Agriculture (2000 and 2001) are that it can tolerate high soil salinity under different soil textures. Assuming that the lowest soil salts concentration tolerable by the wheat cultivar is about 10 dS/m, the

ratings of salinity were adapted; according to Khodier *et al* (1999). The general, soil requirements for wheat cultivation as recognized) by Sys *et al* (1993) and in light of the FAO framework for land evaluation (FAO, 1976) were then taken into consideration to meet the requirements, for sakha- 93 wheat cultivar. The cultivar requirements in terms of soil characteristics are presented in Table 3.

Table 3. Land characteristics and soil requirements for Sakha-93 wheat cultivar.

Land Characteristics	Class, degree of limitation and rating scale*					
	S1			S2	S3	N
	100	95	85	60	40	25 0
	100	95	85	80 55	50 30	25 0
topography(t) Slope%	0-1	1-2	2-4	4-6	-	>6
Wetness (w) Drainage	Good	Moder.	Imperf.	Poor	V.Poor	unsuitable
Physical soil Characteristics(s) Texture/strict.	Recommended for all texture classes					
Soil depth /cm	> 90	90 - 50	50 - 30	30 - 20	20 - 10	< 10
$CaCO_3$%	1 - 25	25 - 55	> 55	-	-	-
Soil fertility Characteristics(f) pH H_2O	7 - 7.5	7.5 - 7.8	7.8 - 8.0	8.0 - 8.3	-	> 8.5
Organic carbon%	> 0.5	0.5-0.1	< 0.1	-	-	-
Salinity Alkalinity (n) EC dS/m	< 10	10 - 15	15 - 20	20 - 25	25 - 30	> 30

*S1 (100-75) very suitable. S2 (75- 50) moderately suitable.
S3 (50-25) marginally suitable. N (25- 0) unsuitable

The soil characteristics of the studied profiles are presented as weighing means of the successive layers of each pedon and the computed land suitability indices by applying the two methods are presented in Table 4. According to Storie method the land suitability indices of the north Delta region for Sakha- 93 cultivar range between 9.18 and 85.73. These indices range between 13.55 and 89.77 when they are computed by the Square Root method. The variation of land suitability values can be attributed mainly to soil salinity where no or slight limitations are due to the other soil characteristics, e.g. topography, drainage, soil depth, $CaC0_3$...etc. The land suitability indices, by Square Root method, are estimated at 13.55 and 19.84 for the soil that have salinity values of 36.72 and 32.5 dS/m, respectively. These data may indicate that there is a need for wheat cultivars more tolerant to soil salinity.

The difference between the obtained results according to the two applied evaluation methods, is due to the fact that the square root method gives less weighing to the severe limiting factor of salinity (Khiddir, 1986).

Table 4. Some soil characteristics and land suitability indices of the studied soil profiles.

Profile No.	Grain size distribution			Texture	EC dS/m	$CaCO_3$ %	O.C. %	Storie method		Square Root method		Limiting Factors*
	Sand %	Silt %	Clay %					Value	Class	Value	Class	
1	68.42	17.02	14.57	Loamy Sand	13.1	0.60	0.07	28.81	S3	40.88	S3	f. w. n.
2	16.53	46.91	36.57	Clay Loam	17.8	1.60	0.13	56.30	S2	68.36	S2	f. n. w.
3	18.18	51.01	31.12	Silt	39.2	1.11	0.38	9.18	N	13.55	N	n. w. f.
4	97.83	0.43	1.74	Sand	36.5	0.16	0.42	17.88	N	19.84	N	n. w. f.
5	97.03	0.67	2.30	Sand	35.4	0.17	0.45	85.73	S1	89.77	S1	w.
6	95.67	0.83	3.50	Sand	18.0	0.93	0.31	66.52	S2	76.51	S1	s. f.
7	96.80	0.80	2.40	Sand	8.44	0.13	0.65	68.36	S2	76.23	S1	s. w.
8	17.17	18.17	64.66	Clay	7.0	1.38	0.51	74.10	S2	78.43	S1	s. w.
9	6.03	32.50	61.47	Clay	9.3	0.87	0.53	85.65	S1	88.77	S1	w.
10	5.70	22.00	72.30	Clay	12.0	2.31	0.55	84.84	S1	88.83	S1	w.s.

Abbreviated limiting factors (f.,w.,n. and s.) are shown in table (3)

CONCLUSION

The salinity of the studied area in North Delta ranges between 7.00 to 39.2 dS/m. According to Storie Index 3 sites are very suitable for Skha-93, 4 sites are moderately suitable, one site is marginally suitable and, 2 sites are unsuitable. Some variations are noticed in comparison with Square Root method, where profiles No. 6, 7 and 8 are very suitable (S1) instead of moderately suitable (S2). Therefore the present study showed that Sakha -93 wheat cultivar, under the proposed assumption, may produce almost 60% of the optimal yield at soil salinity levels of 20 dS/m, providing that it is the only limiting factor. It is also clear that there is great need for wheat cultivar that may tolerate higher levels of soil salinity in order to expand the area of wheat cultivation in the northern part of the Nile Delta. However. Field experiments under different soil salinity levels should be conducted to assess the tolerance of the selected cultivar more precisely.

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ملاءمة منطقة أراضى شمال الدلتا لزراعة القمح صنف سخا-٩٣

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تهدف الدراسة إلى تقييم ملاءمة بعض الأراضى الملحية لزراعة صنف القمح سخا-٩٣ ولتحقيق هذا الهدف تم اختيار عشرة قطاعات أرضية من منطقة شمال الدلتا المتأثرة بالأملاح ووصفت وصفاً مورفولوجيا فى الحقل وأجرى عليها التحليلات الأساسية للتربة وتشمل (قوام التربة، كمية الأملاح ونوعيتها، كربونات الكالسيوم، درجة القلوية.....). وقد أستخدمت طريقتين لحساب معامل ملاءمة التربة لزراعة صنف القمح سخا-٩٣ فى هذه الأراضى وهما storie والجذر التربيعى

وقد وجد من الدراسة أن نسبة الملوحة تتراوح فى القطاعات الأرضية مابين ٦,٤ إلى ٣٦,٧ ملليموز/ سم وكان توزيع الأملاح حسب سيادتها كالتالى:-

كلوريد الصوديم > كبريتات الصوديم > كبريتات الماغنسيوم > كلوريد الكالسيوم > كلوريد البوتاسيم.

وطبقاً لحساب معامل ملاءمة التربة بطريقة storie وجد الاتى:-

ثلاثة قطاعات يمكن اعتبارهم ملائمين جدا لزراعة ذلك الصنف، أربع قطاعات متوسطة الملاءمة، وقطاع يدخل فى حدود الحد الأدنى للملاءمة، وقطاعين غير ملائمين.

على صعيد أخر أشارت النتائج أن هناك إختلاف بين معامل الملاءمة بطريقة storie ومعامل الملاءمة بطريقة الجذر التربيعى حيث يتضح ذلك فى قطاعات أرقام ٦، ٧، ٨ الملائمين جدا طبقاً لطريقة storie لكنهم متوسطى الملاءمة طبقاً لطريقة الجذر التربيعى. كما يمكن بإيجاز الإشارة إلى أن درجة ملاءمة هذا الصنف فى تلك الأراضى تتراوح ما بين ٩,١٨ إلى ٨٥,٧٣ طبقا لطريقة Storie وما بين ١٣,٥٥ إلى ٨٩,٧٧ طبقاً لطريقة الجذر التربيعى على أن الفرق بين الطريقتين يعزى إلى نسبة الملوحة فى الارض ولذلك يوصى البحث على استنباط صنف أكثر تحملا لمستويات الملوحة المرتفعة لإعطاء عامل ملاءمة أعلى.