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THE IMPACT OF CHEMICAL AND PHYSICAL CHARACTERISTICS OF NORTH SINAI SOILS ON THE AGRICULTURAL POTENTIALITIES

Yousef, A. F. and B. M. Hasanein
Desert Research Center, Mataria, Cairo, Egypt

ABSTRACT

North Sinai gained the priority over the other part of Sinai due its strategic location and promising output. The effect of chemical, physical and geological properties of some units of North Sinai soils is studied for future agricultural practices consideration.

Twenty eight profiles have been selected covering the study area of 2830 km^2 in North Sinai. The soil samples were collected from each profile representing geomorphological and lithological changes.

Coarse textured soils are characterized by the predominance of sand over clay and silt. Looseness, friability and good coarse textured soils represent more than 90% of the studied area, while fine textured soils occupy a triangle area in the northwestern part. Most of the northern part has been found free from salt affected soils (< 4dS m^{-1}), while most of the southern part have salt affected soils (> 4dS m^{-1}). The pH of the studied area ranged from 6.2 to 9.0. Due to the low rate of rainfall and limited degree of leaching in the region, calcium carbonate is a common constituent of soils. Organic matter content of the studied soils ranged from 0.3% to 22.6%. The total N content is not adequate for plant growth. The minimum level of P is considered to be the adequate level for plant growth. Potassium content is ranged from adequate to very high level for plant growth. The surface irrigation water of El Salam Canal is suitable for the growth of non sensitive plants, while drainage and subsoil water are not suitable for irrigation. Ground water is suitable for irrigation of non sensitive plants to salinity.

A complete and integrated scientific strategy is required to reduce salinity of soil. Also, maintain acceptable range of nutrients for plant growth is required to build a long-term plan for maximum utilization of North Sinai soils.

INTRODUCTION

The reconstruction of Sinai land after October War 1973 and liberation was deeply considered by the Egyptian government. The North Sinai sector gained the priority over the other parts due to its strategic location and promising output. For example, El Salam Canal was created and crossed the Suez Canal to North Sinai, where land reclamation and cultivation, construction, new community settlement and industrial projects were undertaken to create a new life and change the yellow desert to a new face of green life.

A complete and integrated research studies are required before any planning for agricultural practices. The study of soil survey is the first step needed. The means of aerial photo-technique is used to evaluate the different landscapes and the possibilities of using them for agricultural practices. With the aid of photo-interpretation, certain mapping units are established on some areas of North Sinai. These units represent most of the landscape, which cover the area between the north eastern bank of Suez Canal to El-Arish region (El-Shazly *et al.*,1974; Elwan *et al.*, 1983 and Yousef, 2000). Recently, planning of the location for different purposes and classification according to its suitability, in addition to dividing North Sinai geomorphologically to different units were carried out by Yousef (1998 and 2000).

The main objective of this research is to investigate the effect of geological, chemical and physical properties of some units of North Sinai soils on future agricultural practices.

MATERIALS AND METHODS

Site description:

The site of the study is located between longitudinal lines 32° 20' and 32° 50' and between latitudinal lines 30° 40' and 31° 20' north covering about 2830 km^2 in North Sinai (Fig. 1).

The geological material of the area consists of transitional continental in the southern part, transitional deltaic deposits in the western part and littoral deposits in the northern part. The transitional continental deposits derived mainly from south and east Sinai through the desert wades and the effect of wind. While, the transitional deltaic deposits were derived mainly from the Ethiopian Plateau through the River Nile (Palusaic Branch). But, the marine and eroded Nile Delta sediments constitute the littoral deposits.

The North Sinai topography is ranging from coastal flat of elevation about 1 m above sea level in the north western part and undulating topography in the southern and eastern parts ranges from 2 m to more than 50 m above the sea level.

The mean monthly temperature was 19°C with a difference between 26 C° in dry season and 15 C° in the wet season.

Rainfall is commonly low with an average annual precipitation of 50 mm/y and ranges from 75 mm/y to about 25 mm/y. The daily relative humidity ranges from 52% to 74% as average.

The natural vegetation are rare except few small oasis and scattered farms especially south El Qantara - El Arish road.

Profile selection:

Twenty eight profiles were selected to cover the study area (Fig. 1) according to Yousef (1998) geomorphological classification. The soil samples were collected in different depths according to the geomorphological changes as follow:

1- Sandy shore zone 1, 2, 4
2- Coastal plain 3, 5,9, 10, 11
3- Nile flood plain 12, 13, 14, 15,16, 17, 18
4- Sand dune belt 21, 22, 23, 24, 25, 26, 27, 28
5- Sabkhas 6, 7, 8, 19. 20

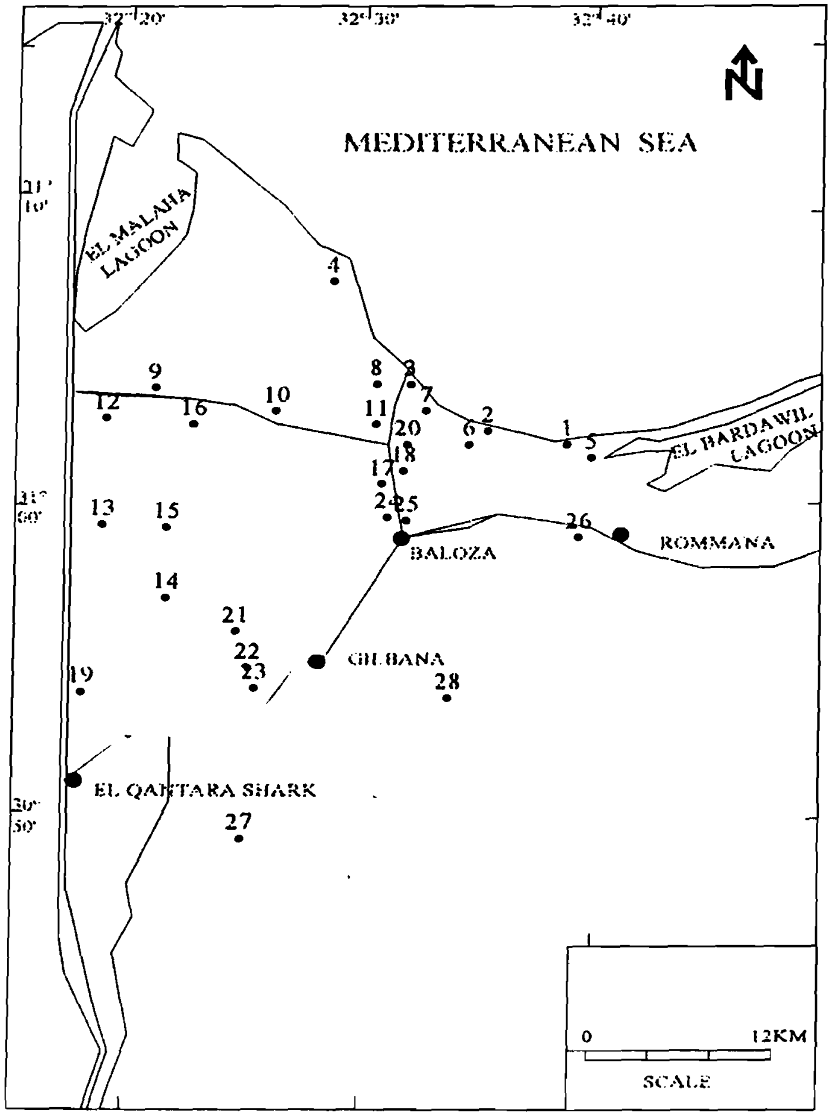


Fig. (1):Location map of the studied profiles in North Sinai.

The above profiles according to the lithological changes, texture, sedimentological structure and the environment of deposition we can group as the following lithological units as follows:

1- Littoral 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 20
2- Transitional deltaic 12, 13, 14, 15, 16, 17, 18, 19
3- Transitional continental 21, 22, 23, 24, 25. 26, 27, 28

Laboratory analysis:

1- Particle size distribution: was carried out according to Jackson (1967) by the Pipette method.
2- Soil Reaction (pH): was determined in soil paste as indicated by Richards (1954).
3- Total soil salinity (ECe): was determined in soil paste by measurement of electric conductivity according to Black (1965).
4- Cation exchange capacity (CEC): was conducted according to Bower *et al.* (1952).
5- Organic matter (O.M.%): was determined as indicated by Jackson (1967).
6- Calcium carbonate content ($CaCO_3$%): was carried out by using calcimeter (Piper, 1950).
7- Sodium content (Na): was determined by using flamephotometer (Jackson, 1967).
8- Total nitrogen (N%): Kjildahl method as described by Jackson (1967) was followed
9- Available phosphorus (P ppm): was extracted and determined as indicated by Olsen *et al.* (1954).
10- Available potassium (K ppm): was extracted by ammonium acetate and determined as indicated by Jakson (1967).

RESULTS AND DISCUSSION

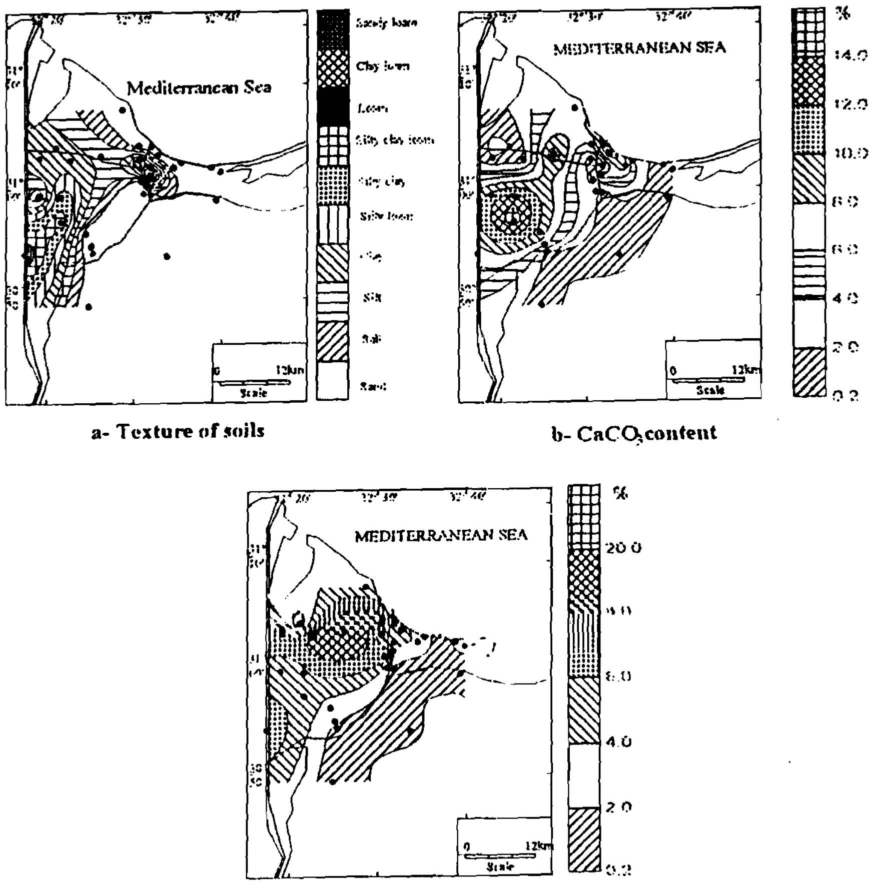
Factors controlling fertility of soils:

Fertility is a term that can refer to the inherent capacity of a soil to supply nutrients in adequate and suitable amounts. There are some factors, which control the fertility of soils in the selected profiles of the study area such as the type of soil, moisture, pH, heavy metals, kinds of soluble or exchangeable cations, organic matter and the type of plants (Russel, 1978).

1. Soil texture:

Loosen, friability, coarse textured soils represent more than 90% of the studied area, while fine textured soils occupy a triangle area in the northwestern part. Soils of fine to medium texture are characterized by the predominance of clay and silt over sand (Fig. 2). Their clay particles are characterized by high adsorptive capacity for water and cations due to their negative changes. These soils are located in the northwestern part of North Sinai around the course of Palusaic Branch and El-Malaha Lagoon.

Coarse textured soils are characterized by the predominance of sand over clay and silt. These soils are located in the southern and eastern part of the studied area.



a- Texture of soils

b- $CaCO_3$ content

c- Organic matter content

Fig. (2): Physical proporties of the studied profiles.

2. Calcium carbonate content:

Calcium carbonate may play an important role in aggregation and acts as cement especially in semi-arid soils. Due to the low rate of rainfall and limited degree of leaching in the region, calcium carbonate is a common constituent of soils (Fig. 2). There is a positive correlation between $CaCO_3$ and aggregate stability (Abd El-Azim, 1964).

Calcium carbonate in the studied area is relatively higher in the northwestern part of the Nile flood plain, and sabkha deposits as well as deposits south El- Malaha and El-Bardawil Lagoon than in the southern and eastern parts (Fig. 2). Generally, the presence of calcium carbonate raises the pH values. The addition of neutral salts of Ca^{++} such as $CaSO_4.2H_2O$ (gypsum) is often needed for soils of high pH values to increase calcium ion concentration.

3. Organic matter content:

The role of O.M. in soil can be outlined in the following points:

- It acts as a granulator of the mineral particles.
- It is a major source of two important elements, phosphorus and sulphur and the sole source of nitrogen.
- It tends to increase the amount of H_2O in a soil can held a proportion of this water available for plant growth.
- O.M. is the main source of energy for soil microorganisms.

Organic matter content of the studies soils ranges from 0.3% to 22.6% (Fig. 2) . The soils of sabkhas and the Nile flood plain deposits are more organic rich than other soils . This is due to the effect of dense natural vegetation in sabkhas and old roots of vegetation in the cultivated Nile Flood Plain deposits . The correlation between available nitrogen content and O.M. has been found positively significant. On the other hand, available phosphorus shows insignificant correlation with O.M.

4. Soil salinity:

Salinity and soluble cations affect soil physical properties, plant growth and nutrients availability. The correlation between soluble calcium percentages and the degree of aggregation is significant, meanwhile, the correlation between soluble Mg^{++} and the degree of aggregations is not significant (Fathi *et al.* 1971).

A negative significant relationship was found to exist between soluble sodium percentage and the degree of aggregation. Most of the northern part has been found, free from salt affected soils (ECe < 4 dS/cm at 25°C), while most of the southern part was found to be salt affected soils (ECe > 4 dS/cm at 25°C). Sodium is predominant, whereas, calcium and magnesium are generally of low content (Fig. 3 and 4).

The predominance of sodium over Ca^{++} and Mg^{++} (Fig. 4) in such soil solution reduces the permeability due to the replacement of exchangeable Ca^{++} and Mg^{++}. The relation between nitrogen and ECe is negatively significant, while phosphorus and potassium are positively significant.

5. Soil Reaction (pH):

At high pH and in the presence of carbonate ion, Ca^{++} and Mg^{++} are precipitated, hence the soil solution usually contains small amounts of these cations and sodium becomes predominant. Generally, exchangeable Na^{+} and K^{+} increase with alkalinity, whereas Ca^{++} and Mg^{++} decrease. The effect of physiological toxicity of salts in soda salinization occurs when the pH is 8.7-9.0. The maximum availability of soil phosphorus occurs at intermediate pH values of 6 to 7 where fixation and precipitation of soil phosphorus are at their minimum values. However, the pH of the studied area ranged from 6.2 to 9.0, i.e. from acidity to strongly alkaline, under such conditions the following general observations are recorded:

1- Excess of sodium ion concentrations relative to of Ca^{++} and Mg^{++}.
2- Shortage of available phosphorus which may be attributed to the prevailing alkaline conditions.

6. Irrigation, drainage and groundwater:

Salinity depends directly on water movement, i.e., irrigation, leaching and drainage. Furthermore, the accumulation of salts and their distribution in soil depend on the depth of groundwater and type of their salinization.

Irrigation Canal (El Salam) water ranges from 1344 ppm to 6180 ppm, i.e. from slightly saline to highly saline water. The salinity of the drainage canal water range from 61960 ppm to about 70000 ppm, i.e. very high saline water. With respect to subsoil water, the salinity contents range from 8960 to 176256 ppm, i.e. very high saline to brine water.The groundwater contents range from 813 ppm to 18688 ppm, i.e., which is nearly fresh to highly saline water (Yousef, 1998).

The surface irrigation water of El-Salam Canal is suitable for growing non sensitive plants while drainage and subsoil waters are not suitable for irrigation. However the, groundwater may be suitable for irrigation of non sensitive plants.

Soil Nutrients:

a- Total nitrogen

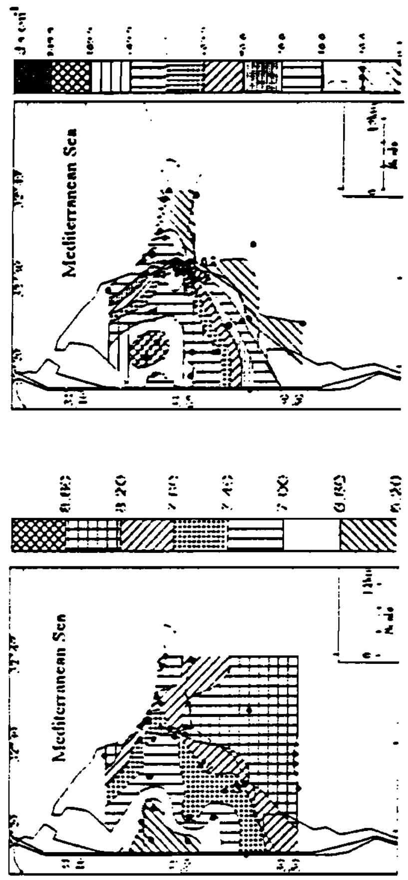
In the studied soil profiles (28 profiles) the levels of total N were found to vary from 0 to 10 mg kg^{-1} with mean of 5 mg kg^{-1} as shown in Fig. (5-a). The distribution of total N shows the same trend as that of the organic matter. The levels of total N are not adequate for plant growth. However, there is a positive relationship between N contents and silt and clay percents.

b-Available P :

Available P content ranged from 8 to 75 ppm with irregular distribution throughout the study area (Fig. 5.b). The mean value of available P is 42 mg kg^{-1}. The minimum level of P is considered to be adequate for plant grow without additional application of P fertilizers. Available P showed insignificant relationship with soil texture.

c- Available K:

The available K levels were found to vary from 80 to 1760 mg kg^{-1} with a mean of 920 mg kg^{-1}. (Fig. 5.c). Which are considered very high levels over plant growth requirements. However, the data presented here indicate that the high levels of K occur in a very high saline area. In the same time, the highest values of available K were found in the heavy textured soils, while the minimum values were found in the light texture soils.



a- Soil reaction (pH)

b- Soil salinity (EC)

Fig. (3): PH and EC distribution of the studied profiles.

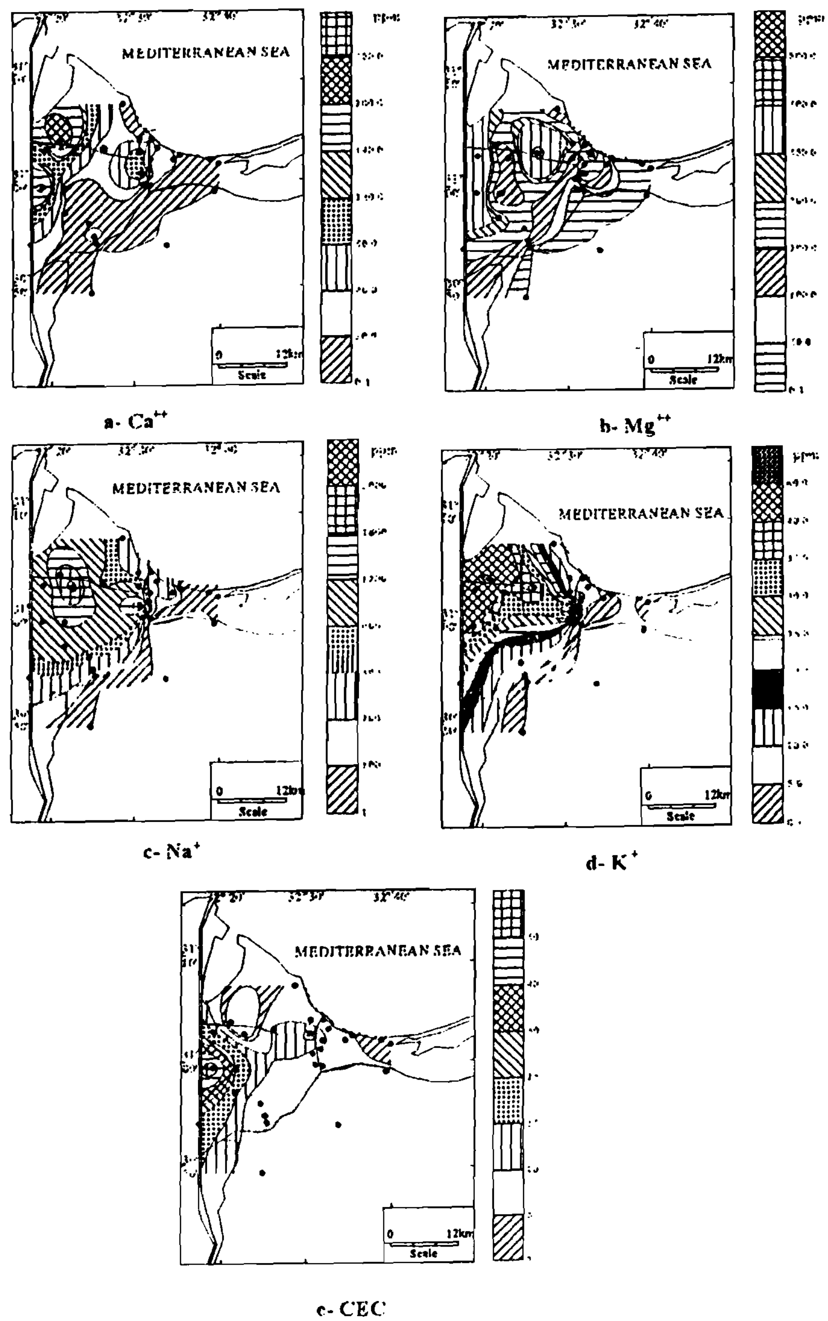
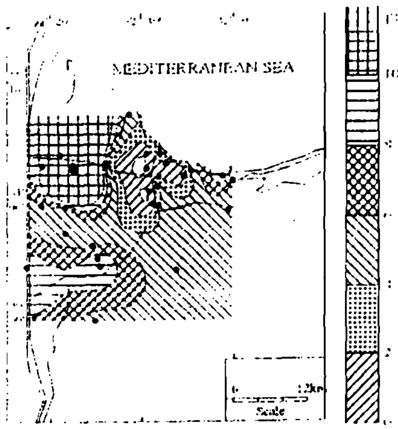
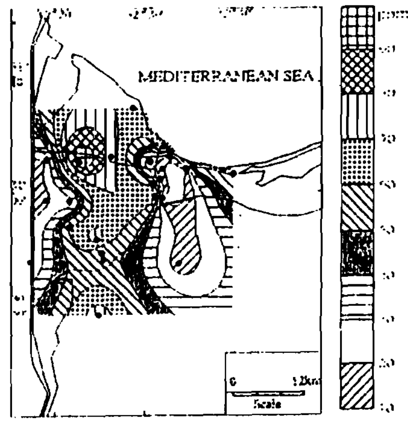


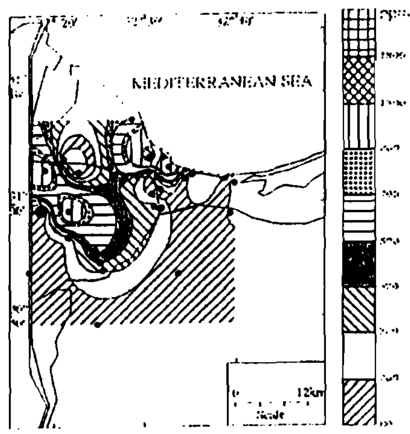
Fig. (4): Cations and CEC distribution contour maps of the studied area.



a- Total Nitrogen (N)



b- Avaliable Phoshors (P)



c- Avaliable potassium (K)

Fig. (5): Nutrient availability of N, P and K in the studied profiles.

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الإمكانية الزراعية لبعض أراضى شمال سيناء المتأثرة بالخواص الجيولوجية و الكيميائية و الطبيعية للمنطقة

احمد فوزى يوسف ، بدران مرسى حسنين
مركز بحوث الصحراء- القاهرة

إن منطقة شمال سيناء لها أهمية خاصة نظرا لموقعها الاستراتيجى و أراضيها الواعدة. و لذلك فقد تم دراسة أثر الخواص الجيولوجية و الطبيعية و الكيميائية على بعض أراضى شمال سيناء لإمكانية الزراعة بالمنطقة.

يبين التركيب الميكانيكى أن ٩٠% من منطقة الدراسة ذات قوام خشن حيث يسود الرمل على السلت و الطين . كذلك يحتوى معظم الجزء الشمالى على أملاح أقل من ٤ ديسيسمنس / متر، بينما الجزء الجنوبى يحتوى على ملوحة أعلى من ٤ ديسيسمنس / متر . تتراوح درجة حموضة التربة ما بين ٦,٢ إلى ٩,٠ . و يسود مركب كربونات الكالسيوم بالمنطقة. و تتراوح نسبة المادة العضوية ما بين ٣, % و ٢٢,٦%. و تعتبر ترعة السلام مناسبة لرى النباتات الغير حساسة للملوحة . و بالنسبة للعناصر المغذية فإن محتوى النيتروجين الكلى يعتبر غير كافى لنمو النبات و يعتبر مستوى الفوسفور و البوتاسيوم الميسر كافيا لإمداد النبات بهذين العنصرين لفترة طويلة حيث أن النتائج تؤكد ارتفاع قدرة الأرض على إمداد العنصرين بدرجة ملحوظة.

إن دراسة متكاملة ذات خطة استراتيجية على المدى الطويل لتقليل ملوحة التربة و مياه الرى و وضع برنامج للاستفادة القصوى من منطقة شمال سيناء تعتبر ضرورة ملحة فى المرحلة المقبلة.