THE AEOLIAN SOILS OF THE NORTHERN NEGEV[1])

By

S. RAVIKOVITCH

The region under investigation, the northern Negev, is within the boundaries of the arid and semiarid belts of Israel (Diagram 1, p. 3)[2]. We meet here desert soils, which differ greatly from their counterparts found in similar climatic regions of other districts of the country. They are aeolian in origin and were deposited according to certain characteristic patterns. The aim of this study was to investigate the nature and properties of these soils and to evaluate them from the agricultural point of view.

SOIL TYPES, THEORY OF THEIR GENESIS AND THE NATURE OF THEIR DISTRIBUTION

Most of the Negev soils appear to have developed from dust material brought mainly by southwesterly winds from the deserts of the Sinai Peninsula, where it was formed due to weathering of rocks of various origin. Southerly winds also took part, to a certain degree, in the dust transfer. It is possible that a small part of the dust was supplied by rock weathering that took place in the Negev itself.

The soil raw material brougth to the Negev in state of fine subdivision underwent weathering in the places of its deposition. However, under the climatic conditions prevailing in the region under consideration, these soils did not reach a stage of development and maturity which would make it possible to distinguish readily the various horizons of the profile.

When the Negev soils are divided into the various textural classes and the geographical position of these classes is indicated on a map, one is impressed by a certain regularity in their distribution. Soil texture becomes finer as one proceeds northeastward and northward from the boundary between the Negev and the Sinai Desert and a definite sequence of sandy soils, sandy loams, loams and clay loams can be discerned (Map 1, Table 2, Diagram 2, pp. 8, 9).[2]) This characteristic distribution of textural classes is explained by gradual fractional deposition of the wind borne dusts, as they were carried inland. It furnishes evidence of the aeolian origin of the soils concerned.

The Negev soils are usually light colored, most of them being brownish yellow. They can be classified under three main types (Map 1): (1) Loess soils, (2) Loess-like soils, (3) Brownish-yellow sandy soils.

In addition to the above three main soil types, there exist within the boundaries of the region under investigation several minor soil formations of non aeolian origin.

While studying the morphology of the Negev aeolian soils it was found that in certain areas one of the above three soil types is covered by another. This phenomenon is to be explained by secondary movements of materials. After their deposition it is

1) A more detailed English account of this study appears in the Proceedings of International Symposium of Desert Research, Special Publication No. 2, Research Council of Israel, Jerusalem.

2) Page numbers in parentheses refer to the Hebrew text.

believed that the dusts were stabilized by vegetation which developed upon them. It is because of this stabilizing effect that the winds did not move these deposits further. Later man, cultivating his fields, and his flocks started to destroy the native vegetation. Thus, the soil became bare and unprotected, and certain portion of it started to move slowly, but continuously with the prevailing winds. This movement was facilitated by the looseness of the soils and their poor and unstable aggregation.

Loess Soils. These soils have a structure which makes possible the existence of a consolidated soil profile, a vertical cut through which, though many meters high, will not cave in. Texturally, they fall into the loam and clay loam classes. Particles of diameter between 0.020 and 0.074 mm comprise 70 to 90 per cent of the sand fraction, while the percentage of coarse sand is very low (Table 3, p. 15).

The chemical composition is characteristically uniform within the profile and no marked differences are found between various localities (Table 4, p. 17). The loess soils are moderately alkaline (pH 7.8 to 8.2). They have a high lime content and are rich in potassium compounds, while their phosphorus content is medium to medium-high. The amount of organic matter and nitrogen is low to medium, the C/N ratio varying between 4 and 8. The similarity between the chemical composition of the loess soils and that of the desert dusts suggests that the long period of weathering did not result in far-reaching chemical changes.

The cation exchange capacity of the loess soils is relatively small (Table 7, p. 19). Calcium predominates in the exchange complex of the upper layers, while the percentage of magnesium and sodium increases with depth.

The sand fraction, which consists primarily of quartz, contains a fair amount of calcite and particles of feldspar. Heavy minerals constitute only about one per cent of the sand fraction.

The loess soils are easily cultivable. Their field water-holding capacity is 20 to 22 per cent and the permanent wilting point usually equals 7 to 9 per cent. They conserve moisture well and, with the exception of the heavier types, shrink but little during the summer.

Loess-like Soils. These soils form a transitional type between the loess and sandy soils. They are of lighter and looser texture than the loess soils and do not give a firm profile cut. Their mechanical composition corresponds to that of the sandy loam soils (Table 8, p. 21). Wind erosion is responsible for frequent invasions of the loess soils by these loess-like formations.

The chemical composition of loess-like soils resembles that of loess. The lime content is smaller than in loess. It should be pointed out, that the percentage of lime increases gradually in a northerly direction. This is due to the fact that calcium carbonate is present in the desert dusts in a state of advanced fragmentation and is therefore carried relatively far from its source. This fragmentation is explained by the grinding action of quartz sand on the Sinai Peninsula rock materials.

Apart from the difference in texture, the loess-like soils resemble loess soils in most physical properties. Their field capacity and permanent wilting point are 17—18 and 6 per cent respectively.

Sandy soils. Many of the sandy soils are quite deep. As a result of secondary soil movements it came to be that these soils often cover loess and loess-like soils. Data concerning their mechanical composition and chemical properties are given in Tables

11 to 13 (pp. 25, 26). Their field capacity is approximately 10 per cent and the permanent wilting point about 2 per cent. They have a high infiltration capacity and conserve moisture well.

Sand Dunes. The inland sand dunes are of a finer texture than the coastal dunes (Table 2, p. 8). They are deficient in a number of essential plant nutrients (Table 14, p. 28). However, experiments have shown that sand dunes can serve as a good substrate for irrigated crops.

SALINITY OF AEOLIAN SOILS

The dust material brought by winds from the desert is to a certain degree saline. This would indicate that the raw material from which the aeolian soils were formed contained quantities of soluble salts. Indeed, an investigation of the Negev soils has proved that there are some large areas that are saline (Maps 2, 3). It was found there exists a connection between the degree of salinity and the quantity of rainfall. Salinity is also, to a large extent, dependent on the soil texture: the finer the soil the greater the salinity.

The bulk of the saline soils are found in the drier parts of the region, where the annual rainfall is below 200 mm.

Because of the existence of various types of solonchak soils (Table 16, p. 30), it may be assumed that the salts supplied to the Negev from the desert were not always of the same composition. This is supported by the analysis of samples of wind-borne dust collected in the Israeli territory, which show that the percentage as well as the composition of their salts vary considerably (Table 15, p. 30). The principal salts found in the dusts were sodium chloride and gypsum.

Almost all the salts found in the desert dust were also found in the saline soils of the Negev with the exception of $MgCl_2$ and $CaCl_2$. These latter salts presumably disappeared from the soil due to the ease with which they can be washed away. The relatively high percentage of KCl in dusts in relation to total chloride salts is noteworthy (Table 17, p. 31).

The quantities of salts brought to the Negev from the deserts must have been huge. The degree of salinity and the salt distribution found in the soils of the northern Negev show that the greater part of the salts has already been washed out by the rains. These salts must have found their way into the ground and surface waters, which transferred much of them into the Mediterranean and into the Dead Sea. Thus, it may be assumed that a part of the Dead Sea salts has come from the saline soils of the Negev. Large quantities of magnesium and calcium chlorides should have been formed in the saline soils due to the exchange reaction between NaCl and the exchangeable calcium and magnesium of the soil.

AGRICULTURE

Agriculture in the northern Negev was severely hampered by the low rainfall and the very limited supply of good-quality irrigation water.

The information gained from experiments shows that soils of the Negev are suitable for growing many kinds of irrigated crops. Under arid conditions, these soils can be made to produce good yields of winter crops, by augmenting the scant rainfall through

supplemental irrigation. The fertility of the aeolian soils becomes fully evident when the plants receive the amount of water required for normal growth.

Since wide areas of potential agricultural value exist in the Negev, only a large-scale supply of irrigation water could determine the agricultural future of this dry region, making it possible to exploit fully its productive possibilities.