Salt Circulation in Irrigated Meadow-Chernozem Soils of the Hajdúság Area of Hungary

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Salt occurs at depth in the meadow-chernozem soils in comparatively large areas of the Hajdúság region. These soils are fertile, but sensitive to aridity, because of the shallow fertile layer.

Irrigation increases yields, but the danger of secondary soil salinization is high. Increased levels of ground water caused by irrigation lead to salt accumulation and decreased fertility.

Methods and conditions of the studies

The studies were conducted on irrigated areas of the State Farm at Hajdúszoboszló, Hajdúság. We studied the changes in water soluble salt composition and content and changes in adsorbed cations in the soil. Profiles No. 1, 2, 4 and 5 are meadow chernozem soils with deep-seated salts. The ground water occurs at a depth of about 130–150 cm. Profiles No. 9, 9a and 10 occur on higher areas with ground water at a depth of 220–230 cm.

We studied the changes in the exchangeable cations in the meadow chernozem (No. 12.), the meadow chernozem with deep-seated salts (No. 101.), the meadow chernozems (Nos. 133 and 137.), and the solonetz (No. 104.) profiles during an eight-year period.

The ground water level averaged 3–4 m before irrigation. It gradually rose after the introduction of irrigation. At present, it is about 1.5–2 m, but it rises to 1 m on significant areas during the irrigation season. The causes of the increased level of the ground water were the escape of water from the irrigation canal and heavy irrigation.

From the point of view of secondary salinization, the ground waters have unfavourable composition. In general their salt contents vary specially from 1500–3000 mg./l, to over 10 000 mg./l. Their soda content is high, in most cases above 60%. The major constituents are generally hydrocarbonate and sodium.

Results of the study

The water soluble salt and exchangeable cation content of the soils varied according to the depth to the ground water. The water soluble salts were generally hydrocarbonates of calcium in the upper soil layers and of sodium in the deep layers, near the water table.

Exchangeable Ca^{2+} exceeded 80% of the C. E. C. The quantity of adsorbed Na^{+} was 1 – 2% of the C. E. C. in the upper layers and increased to 15% in the soil layers near the ground water.

We determined salt balances for short and long periods to study the accumulation and leaching of the water soluble salts. We studied the effect of irrigation, rainfall and the ground water on salt movement.

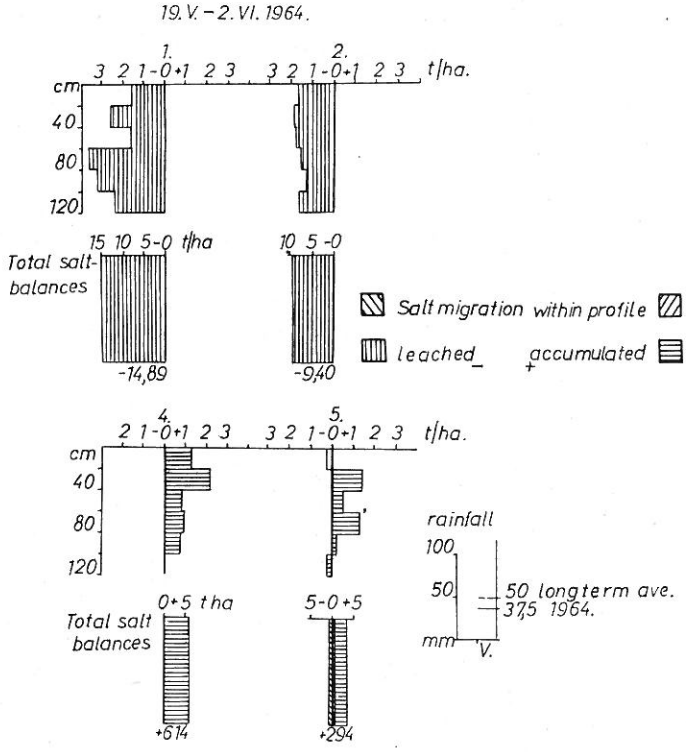

Fig. 1
Salt balances of the short period

A short term study of salt balances (Figs. 1 and 2) showed that the irrigation water leached down and that the ground water rose by capillarity. Irrigation had a significant effect on the salt balance depending on the rates of leaching and capillary rise.

The depth of leaching was equal to the depth of water penetration. The salt content of the soil was reduced by 100—120 mm of irrigation water. The salt reduction exceeded 10 to/ha in the meadow chernozem soil with salts at depth,

Part of the irrigation and canal seepage water entered the ground water and raised its level. This caused salt accumulation in the deeper soil layers. In meadow chernozem soils, where the ground water was comparatively deep, this salt accumulation amounted to 7 to/ha.

The effect of rainfall on salt movement was similar to that of irrigation, but there were quantitative differences. The effects of rainfall were:

I. Leaching: The seepage water washed the soluble salts into the deeper soil layers or into the ground water.

II. Salt accumulation:

1. In the deeper soil layers, where the leached salts accumulated.

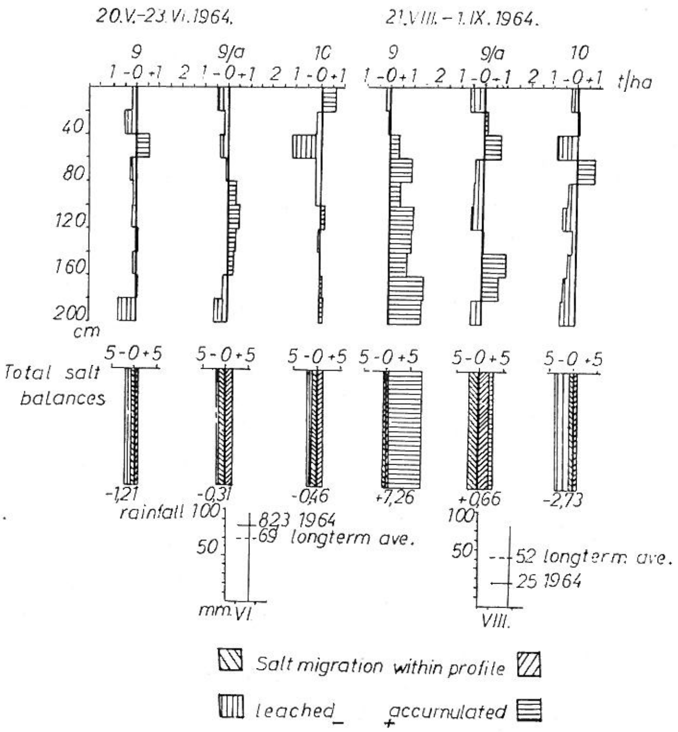

Fig. 2
Salt balances with irrigation

2. In the deeper layers, when high rainfall raised the level of the ground water and caused salt accumulation.

Salt balances generally increased during the summer, because of capillarity.

In general, there was leaching during winter. The seepage moisture washed the soluble salts into the deep soil layers or the ground water.

The degree and sign of the salt balances for 2–4 years were different from the seasonal ones. There was general accumulation during the study period.

During 8 years of irrigation there was a great salt accumulation (Fig. 3). According to the total salt balances, the quantity of accumulated salt was 10–20 to/ha. The HCO_3^- and Na^+ content showed the largest increase. It is typical, that the $Ca^{2+} : Na^{+}$ ratios became very narrow in the deeper soil layers, frequently 1/10 to 1/20 or lower.

During the study there were profound changes in the chemical characteristics of the soil. The soluble salt content of the soil and the quantity of

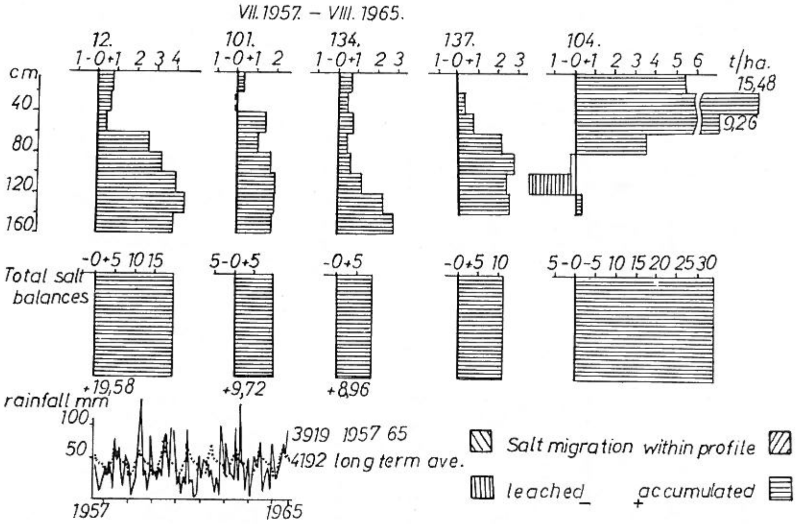

Fig. 3
Salt balances of the long period

exchangeable Na^{+} increased. At the same time significant secondary leaching started.

The soil under study salinised. This salinization can best be controlled by preventing a rise in the ground water. The best method of prevention is the establishment of deep drainage canals.