EFFECT OF VARYING Mg/Ca RATIO AND ELECTROLYTE CONCENTRATION IN THE IRRIGATION WATER ON THE SOIL PROPERTIES AND GROWTH OF WHEAT

by J. S. P. YADAV† and I. K. GIRDHAR‡

Central Soil Salinity Research Institute, Karnal, India

KEY WORDS
Mg/Ca ratio Soil properties Water quality Wheat yield

ABSTRACT
This paper discusses the results of a pot experiment conducted to study the effect of irrigation waters having varying Mg/Ca ratio (2, 4, 8 and 16) and electrolyte concentration (20 and 80 meq/l) on the soil properties and growth of wheat crop in two different soils. The development of salinity in the soils generally increased at higher electrolyte concentration of the irrigation water, but it was of a greater magnitude in the heavy-textured black soil dominated by montmorillonite clay mineral than in the light-textured alluvial soil having illite type of clay mineral. The accumulation of soluble salts as a result of saline water irrigation was higher in the surface layer than in the subsurface layer in both soils. The adsorption of Na and Mg in the soils increased with an increase in the Mg/Ca ratio and electrolyte concentration of the irrigation water. These changes in soil properties were adequately reflected by the grain and dry matter yields of wheat crop, which showed a significant reduction with an increase in the Mg/Ca ratio and electrolyte concentration of the irrigation water. However, the effects of these treatments were more pronounced in the heavy black clay soil than in the alluvial soil. Thus, the role of Mg is different from that of Ca under the conditions used in the experiment.

INTRODUCTION
In many arid and semi-arid regions, ground water is either the major or the only source of irrigation to supplement the scanty rainfall. The majority of the ground waters encountered in these regions are invariably of poor quality due to the excessive salt concentration, higher values of sodium adsorption ratio (SAR*) and residual sodium carbonate (RSC**) or presence of toxic elements and thereby present a serious problem. On the whole, the problem caused by high

† Director; ‡ Soil Scientist.
* SAR = Na+/[(Ca²⁺ + Mg²⁺)/2]
** RSC = (CO₃²⁻ + HCO₃⁻) - (Ca²⁺ + Mg²⁺)
Where concentration of ions is expressed as meq/l.

413

electrolyte concentration and SAR values in ground water is more severe and extensive as compared to that of RSC in India. Further, in most cases the relative proportion of Mg as compared to Ca is higher and often, the Mg/Ca ratio increases with an increase in the salinity level of these poor quality ground waters.

Besides the adverse effects caused by the amount and nature of the soluble salts, the varying Mg/Ca ratio at different salt concentrations in the irrigation waters seems to play an important role in influencing the soil properties and plant growth. It is still disputed whether Mg should be grouped with Ca or Na for calculating the SAR values, and also for determining the suitability of irrigation waters and classifying the salt-affected soils. According to some workers, Mg acts like Ca in influencing the physicochemical properties of soil owing to the divalent nature of the cation. On the other hand, some workers believe that Mg should not be coupled with Ca in view of the varying affinity for adsorption on the exchange surface of the soils.

Keeping in view the above diverse opinion regarding the role of Mg, the present investigation was undertaken to evaluate the effects of different qualities of the irrigation water having varying Mg/Ca ratio and electrolyte concentration on the soil properties and the grain yield of wheat crop.

MATERIALS AND METHODS

An experiment was conducted in pots, using the normal sandy loam soil collected from Karnal and medium black clay soil collected from Indore at the Central Soil Salinity Research Institute, Karnal (India). The artificially prepared different qualities of waters used for irrigation included four Mg/Ca ratios (2, 4, 8 and 16) and two electrolyte concentrations (20 and 80 meq/l) having SAR 10. The chloride salts of Ca, Mg and Na were used for preparing the above irrigation waters throughout the experiment. In calculating the SAR of the irrigation waters, Mg was grouped with Ca as is widely followed. The locally available good quality water was used as control. Each treatment was replicated three times in a split-split plot design. Application of nitrogenous, phosphatic and potassic fertilizers was made as per the usual recommendation. Before sowing wheat, a pre-sowing irrigation was given to the soil with water having composition as per the treatments. Wheat seeds (var. HD-2009) were sown on November 10, 1976 and only 4 plants were retained in each pot after proper establishment of germination. At each irrigation, 4 cm water of the desired quality was applied after every 5 cm of cumulative pan evaporation value, which led to a total application of 44 cm water during the entire crop season in each treatment. The crop was protected from rain, though the amount of rainfall received during the growth period was very small. The crop was harvested at maturity on March 27, 1977.

The initial samples of both the soils used in the experiment were analysed for the important physical and chemical properties and the relevant data are given in Table 1. After the harvest of the crop, soil samples were drawn from 0–7.5 cm and 7.5–15 cm depths in each pot and were analysed for pH and EC in 1:2 soil water suspension and for exchangeable cations by the standard procedures described in U.S.D.A. Handbook 60[18]. The observations on the dry-matter production and grain yield of wheat were recorded at maturity. Statistical analysis was carried out for evaluating the significance of the effect of the different treatments.