Journal of Water and Soil
Vol. 30, No. 6, Jan.-Feb. 2017, p. 1954-1963

نشریه آب و خاک (علوم و صنایع کشاورزی)
جلد 30، شماره 6، بهمن – اسفند 1395، ص. 1963-1954

Adsorption Isotherms of Boron in Soil: the Effects of Sodium Adsorption Ratio (SAR), pH and Ionic Strength

M. Moghbeli[1]- M. Farahbakhsh[2]*- N. Boroomand[3]
Received: 30-09-2014
Accepted: 10-10-2016

Introduction: Boron (B) is an essential plant micronutrient whose soil availability is influenced by many soil factors. Understanding the processes controling activity of boron (B) in the soil solution is important for soil fertility management. The reaction of adsorption and desorption of boron in soil determines the amount of boron that is available to plants. Adsorption–desorption processes play a major role on boron equilibrium concentration and therefore on its bio-availability. Ionic strength, pH and ionic composition in exchangeable phase are among themajor factors affecting B adsorption reactions.Reducedadsorption of boron at high pH is because of a surface potential decrease onminerals with pH-dependent charge. Ionic strength has also a considerable effect on B adsorption.Several studies have been performed inthe adsorption of boron and the effect of factors such as ionicstrength and cations has been understudied, however, the effect of sodium adsorption ratio and itsinteraction with the ionic strength on boron adsorption behavior has not been reported. In thisstudy, the adsorption isotherms of boron in the soils affected by the combined effects of ionic strengthand sodium adsorption ratio were investigated.

Materials and Methods: In order to assess the effects of ionic strength (IS) and Sodium Adsorption Ratio (SAR) on availability of B, the adsorption of B was investigated in a calcareous soil that hadlow levels of electrical conductivity, sodium adsorption ratio and available P. For this purpose, 5 g soil wasequilibrated with 20 mL of B solution (0, 2, 5, 8, 10, 15, 20 mg L^{-1}) in 0.02, 0.06 and 0.12 M background solutions (prepared by NaC1,$CaC1_2.2H_2O$, $MgCl_2.6H_2O$), at two SAR levels (20 and 100).The reaction temperature was 25◦C. The suspension was centrifuged, filtered, and a sample was removed and B was determined by Azomethine-H spectrophotometric method (at a wavelength of 420 nm). B adsorption in Soil was obtained by subtracting B in solution after filtration, from added boron.

Results and Discussion: The Langmuir isotherm waswell fitted to the adsorbtiondata based on the R^2 and SEE.At different IS and SAR levels, the soil exhibited different adsorption behaviors. The effect of SAR on the boron adsorption was greater at high concentrations.The results showed the increase in sodium adsorption ratio,increased soil pH and Boron adsorption.An increase in sodium adsorption ratio up to 100 resulted in a small increase in Boron adsorption compared to SAR=20. With sodium adsorption ratio of 100, soil pHincreased from 8.3 to 8.7. At about PH=9.5, maximum adsorption occurs because boron dissociation is greater when pka = pH. Increasing ionic strength increased the boron adsorption; the absorption rate wasmuch higher at higher ionic strength.Model-predicted and experimental parameters obtained using the Langmuir equation pointed to the large effect of salt concentration on the boron adsorption which wasan increase of around 10% and 75% in q max as a result of an increase in salt concentration from 0.02 to 0.06 and 0.12 M respectively. We can ignore the effect ofsalt at very low equilibrium concentration; however, it increases gradually with increasing the equilibrium concentration of boron.

Conclusion: The results of the present study showed that sodium adsorption ratio was low, in low equilibrium concentration related to low boron concentration, but the equilibrium concentration of boron increased with increasing the sodium adsorption ratio.In sodium adsorptionratio of 100, increasing pH increased the adsorption of boron. Boron adsorption was increased with increasing ionic strength; the adsorption rate was muchhigher than the rate of increase in ionic strength.Increasing the ionic strength suppresses the DDL on planar surface and therefore more negative borate ions are able to move close enough to interact with the adsorption sites located on the edge surfaces. Assuming that this phenomenon affects the adsorption of boron, the effect of ionic strength on boron adsorption can be partly dependent on it. Due to the high variability of soil minerals and the differences in their chemical properties, interpretation of the effect of ionic strength on adsorption of boron is not easy, but we can say that it is the sum of the effects of the above-mentioned factors. The positive effect of ionic strength on boron adsorption may suggest that the formation of inner sphere complex is the dominant mechanism for boron adsorption.

1 and 2- Former MSc Student and Associate Professor, Department of Soil Science, Faculty of Agriculture, Tehran University
(*- Coresponding Author Email: mfbakhsh@ut.ac.ir)
3- Associate Professor, Department of Soil Science, Faculty of Agriculture, Shahid Bahonar University, Kerman

Keywords: Boron, Diffuse double layer, Ions exchangeable, Sodium adsorption ratio