Package ‘QI’

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Title Quantity-Intensity Relationship of Soil Potassium

Version 0.1.0

Description The quantity-intensity (Q/I) relationships, first introduced by Beckett (1964), can be employed to assess the K supplying capacity of different soils based on solid-solution exchange equilibria. Such relationships describe the changes in K+ concentration in the soil solution (or the intensity factor) in relation to the corresponding changes in K+ at exchange sites of the soil (or the capacity or quantity factor). Activity ratio of K to Ca or Ca+Mg is generally used as the variable denoting the intensity, whereas, change in exchangeable K is used to denote the quantity factor.

Imports ggplot2

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Contents

df — *Example Data Frame for Quantity-intensity relationship*

Description

User is advised to prepare the data as suggested in the example to derive Quantity-Intensity (Q/I) relationship parameters of soil potassium (K) using linear and polynomial (second order) regression

Usage

```
df
```

Format

Data frame with Solution: soil ratio in the first column, Initial K concentration (mg/L) in the second column, Final or equilibrium K concentration (mg/L) in the third column, Final or equilibrium 'Ca+Mg' concentration (mol/L) in the fourth column. Write the following notations on the spreadsheet:

Solution_to_Soil_Ratio - for Solution: soil ratio

Initial_K - for Initial K concentration (mg/L)

Final_K - for Final or equilibrium K concentration (mg/L)

Final_Ca_and_Mg - for Final or equilibrium 'Ca+Mg' concentration (mol/L)

QIlin — *Quantity-intensity relationship derived through linear regression*

Description

The quantity-intensity (Q/I) relationships of soil K, introduced by Beckett (1964), is implemented in this function using linear regression equation as used by some earlier workers (Zhang et al., 2011; Islam et al., 2017; Das et al., 2019; 2021).

Usage

```
QIlin(Solution2Soil = Solution2Soil, CKi = CKi, CKf = CKf, CCaMg = CCaMg,
NH4OAC_K = NH4OAC_K)
```

Arguments

`Solution2Soil`	Ratio of solution volume to soil mass (mL/g or L/kg)
`CKi`	Initial K concentration (mg/L)
`CKf`	Final or equilibrium K concentration (mg/L)
`CCaMg`	Final or equilibrium 'Ca+Mg' concentration (mol/L)
`NH4OAC_K`	K extracted from soil by 1 N ammonium acetate (NH4OAc) of pH 7 (mg/kg)

Details

A number of parameters related to soil K availability can be obtained from the Q/I plot, e.g., equilibrium activity ratio (AReK), total labile K (KL), non-specifically held K (-deltaK0), specifically held K (Ks), potential buffering capacity (PBCK), and standard free energy of exchange (deltaG0). The equilibrium activity ratio (AReK) is defined as the activity ratio of K to Ca or 'Ca+Mg' when there is no net adsorption or desorption of K between soil solution and exchange phases. It is a measure of the intensity factor. Total labile K is the amount of K held on the soil solids which is capable of ion exchange reactions during the time period provided for equilibration between soil solution and soil solids. It is a measure of the quantity factor. Conventionally, the total labile K has been sub-divided into non-specifically held K, which is mainly bound to the planar sites; and specifically held K, which is mainly bound to the edge/wedge positions of 2:1 clay minerals (Sparks and Liebhardt, 1981). The potential buffering capacity (PBCK) is a measure of the ability of a soil to resist the changes in intensity factor after additions or losses of K from the system.

Value

AReK - Equilibrium activity ratio (unitless) -deltaK0 - Non-specifically held K (cmolc/kg) Ks - Specifically held K (cmolc/kg) PBCK - Potential buffering capacity (cmolc/kg) deltaG0 - The standard free energy of exchange (cal/mol)

References

Beckett, P.H.T., 1964. The immediate Q/I relations of labile potassium in the soil. European Journal of Soil Science 19, 9-23.

Bilias, F., Barbayiannis, N., 2018. Contribution of non-exchangeable potassium on its quantity-intensity relationships under K-depleted soils. Archives of Agronomy and Soil Science 64, 1988-2004.

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Das, D., Nayak, A.K., Thilagam, V.K., Chatterjee, D., Shahid, M., Tripathi, R., Mohanty, S., Kumar, A., Lal, B., Gautam, P., Panda, B.B., Biswas, S.S., 2018. Measuring potassium fractions is not sufficient to assess the long-term impact of fertilization and manuring on soil's potassium supplying capacity. Journal of Soils and Sediments 18, 1806-1820.

Evangelou, V.P., Blevins, R.L., 1988. Effect of long-term tillage systems and nitrogen addition on potassium quantity-intensity relationships. Soil Sci. Soc. Am. J. 52, 1047-1054.

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Le Roux, J., Summer, M.E., 1968. Labile potassium in soils, I: Factors affecting the quantity-intensity (Q/I) parameters. Soil Science 106, 35-41.

Sparks, D.L., Liebhardt, W.C., 1981. Effect of long-term lime and potassium application on quantity-intensity (Q/I) relationships in sandy soil. Soil Science Society of America Journal 45,786-790.

Zhang, H., Xu, M., Zhu, P., Peng, C., 2011. Effect of 15-year-long fertilization on potassium quantity/intensity relationships in black soil in Northeastern China. Communications in Soil Science and Plant Analysis 42, 1289-1297.

Examples

```
with(data = df, QIlin(Solution2Soil = Solution_to_Soil_Ratio, CKi = Initial_K,
CKf = Final_K, CCaMg = Final_Ca_and_Mg, NH4OAC_K = 55))
```

QIPoly — *Quantity-intensity (Q/I) relationship of soil K derived through a second order polynomial i.e., quadratic equation*

Description

A quadratic equation of the form "y = ax2 + bx + c" can be fitted to Q/I data to find out different Q/I parameters

Usage

```
QIPoly(Solution2Soil = Solution2Soil, CKi = CKi, CKf = CKf, CCaMg = CCaMg)
```

Arguments

`Solution2Soil`	Ratio of solution volume to soil mass (mL/g or L/kg)
`CKi`	Initial K concentration (mg/L)
`CKf`	Final or equilibrium K concentration (mg/L)
`CCaMg`	Final or equilibrium 'Ca+Mg' concentration (mol/L)

Value

AReK - Equilibrium activity ratio (unitless) Kl - Total labile K (cmolc/kg) PBCK - Potential buffering capacity (cmolc/kg) deltaG0 - The standard free energy of exchange (cal/mol)

References

Wang, J.J., Harrell, D.L., Bell, P.F., 2004. Potassium buffering characteristics of three soils low in exchangeable potassium. Soil Science Society of America Journal 68, 654-661.

Wang, J.J., Scott, A.D., 2001. Effect of experimental relevance on potassium Q/I relationships and its implications for surface and subsurface soils. Communications in Soil Science and Plant Analysis 32, 2561-2575.

Examples

```
with(data = df, QIPoly(Solution2Soil = Solution_to_Soil_Ratio, CKi = Initial_K,
CKf = Final_K, CCaMg = Final_Ca_and_Mg))
```

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