

Ministry of Higher Education and Scientific research



Department of Soil and water

College of Agriculture

University of Salahaddin

Subject: Soil Chemistry

Course Book – (Year 2)

Dr. Haifa Sadik Akrawi

Dr. Kazhin Sarbaz

Academic Year: 2022/2023

Course Book

1. Course name	Soil chemistry
2. Lecturer in charge	Theory Dr. Haifa S. Akrawi Practice Mr. Muslim Rasul Arab
3. Department/ College	Soil and Water Science / Agriculture
4. Contact	e-mail: Haifa.yaseen@su.edu.krd e-mail: Kazhin.rajab@su.edu.krd
5. Time (in hours) per week	For example Theory: 2 Practical: 3
6. Office hours	Availability of the lecturer to the student during the week
7. Course code	
8. Teacher's academic profile	<p>A- Theory:- e.g Webpage, Blog, Moodle...</p> <ul style="list-style-type: none"> • Undergraduate in the Plant Production, College of Agriculture/ Univ. of Duhok, Kurdistan region-Iraq / 1996. Since 1998 worked in the college of agriculture. in 2002 get the M. Sc, in Agriculture -Soil and Water Science – Soil Fertility/ Univ. of Salahaddin Erbil, Kurdistan region-Iraq . and get the Ph.D in Agriculture - Soil and Water Science – Soil chemistry/ Univ. of Salahaddin Erbil, Kurdistan region-Iraq / 2010, during my PhD work I travelled to American university of Beirut (AUB). • Employment 2010- Lecturer Dept. of soil and water science, College of Agriculture, Univ of Salahaddin Erbil, kurdistan region-Iraq. 2002- 2009 Assistant Lecture Dept of Soil and Water, College of Agriculture, Univ of Salahaddin Erbil, kurdistan region-Iraq. • Research and publications • Mesopotamia Journal of Agriculture, Determination of potassium desorption index of some soil orders in Kurdistan region-Iraq. 2012

	<ul style="list-style-type: none"> • Effect of levels of phosphorus and iron on growth, yield and quality of Flax. IOSR Journal of Agriculture and veterinary science. Vol. 7, Issue 5, may 2014. • Effect of Q/I parameter on limiting soil Potassium critical levels of some soil order at Kurdistan regain- Iraq • Membership • Member of Kurdistan Agronomist Syndicate, Erbil, Iraq. 1997 • Member of Soil Science Sociality American journal (SSSAJ) member # 356004 • Member of Iraqi Science of Soil Science. 2011 <p>B- Practice:</p>
<p>9. Keywords</p>	<p>Soil menials, pH, Ion exchange, CEC, Soil reaction, Ion Pair ,</p>
<p>10. Course overview: In this section the lecturer shall write an overview about the subject he/she is giving. The course overview must cover:</p> <ul style="list-style-type: none"> • Soil Chemistry :- it is a branch of edaphology science studies mainly the reactions involved in the soil solution and the solid-liquid interface. <p>In this course, we will review and introduce the rules of soil chemistry in soil development and get knowledge in interactions between soil solids, and solution phases including: clay minerals Soil building minerals ,Crystal structure – basic mineralogy, the phyllosilicates – structure and properties, Soil particles specific surface, ion exchange, cataion exchange capacity CEC, adsorption, desorption, soil buffering, ion pair , soil reaction, salinity , and models of solution and solid phase interactions.</p> <p>Soil chemistry of the soil is very important to determine the type of grow and gating information on how to grow. The most soil chemical properties effecting on plant growth is Soil reaction pH. The agriculture soil pH ranged between 5.5 to 7.5. The above pH 7 soil is alkaline while it will be acide at pH below the 7. Soil pH effected on availability of most plant nutrient for example phosphorus is one of essential element its be available as forms H₂PO₄ and HPO₄ at pH =7.2.</p> <p>Next to photosynthesis and respiration, probably no process in nature is as vital to plant and animal life as the exchange of ions between soil particles and growing plant roots</p>	

- **Ion exchangeable:- The substitution of one ion for another on the surface or in the interstitial spaces of a crystal**
 - Cation exchange (e.g., Ca^{2+} for K^{+})
 - Anion exchange (e.g., H_2PO_4^- for NO_3^-)

The main aims of the course are to let students gain knowledge about .

- 1- Main parameters study the linked between soil chemistry and other branches of soil science.
- 2- Effect of type of clay mineral on soil properties and on cation hold by process cation exchange capacity dependent on the negative charge on clay colloid and organic matter.
- 3- The study stricture of clay Mineral and kind of clay colloids,
- 4- Main processes of ion exchangeable clay on hold positive cations from leaching while keeping these cation available for plant uptake and retards the release of pollutants to groundwater
- 5- The role of soil chemical properties on soil fertility and the availability of nutrient

After study all soil chemical properties can recommended and determine the system of Irrigation and fertilization

- The importance of studying the subject
- Understanding of the fundamental concepts of the course
- Principles and theories of the course
- A sound knowledge of the major areas of the subject
- Sufficient knowledge and understanding to secure employment

11. Course objective:

- 1- understanding soil chemical reactions and how the soil relates chemically with the environment.
- 2- Soil building minerals, Crystal structure – basic mineralogy. And the phyllosilicates – structure and properties
- 3- Studying type of mineral in soil: and get information about characteristic of 1:1 , 2:1 and 2:1:1 clay mineral
- 4- Studying soil chemical properties: Soil Reaction , Cation exchange capacity, Ion exchange,
- 5- Studying the source of negative charge on colloid and organic matter surface.

- 6- Studying the application of thermodynamic in the soil.
- 7- To studying soil buffering capacity
- 8- Studying the how increasing fertilizer efficiency.
- 9- Effect of ion pair on availability of element in soil solution.
- 10-Studying the effect of soil chemical properties on applied and fertilizer recommendation.

12. Student's obligation

Attendances, Quizzes will be randomly distributed throughout the semester, homework, 2 monthly exams.

13. Forms of teaching

Powerpoint, datashow, whiteboard.

14. Assessment scheme

Quizzes: quizzes and student activity 5%

Monthly exams 20%

15. Student learning outcome:

The student shall obtain a fundamental understanding of Soil chemistry and use this knowledge to conduct rudimentary environmental risk assessments of emissions of chemical nutrient toxins to the environment.

The student get a information about our soil properties, know all soil condition have a knowledge about the soil problem , risk and investigate the solve problem. Describe the soil cation or plant nutrient like P, N, Ca, Mg, K And have information any of these nutrient found in higher or lower amount than others. And give a recommended about the suitable amount of fertilizer using to decrease soil and water pollution and increase farmers profit during the year. Further that the student get information about how the soil effect on Earth's climate.

Identify on the most type of minerals in the soil and study its effect on availability of nutrient and soil behaviour.

learn how management practices in both forestry and agriculture affect soil quality and sustainability. Student understanding and encourages organic agriculture and known how soil chemical properties effect on the role and activity of macro organize and soil organic matter.

16. Course Reading List and References:

References

- 1- Lindsay, W (1979). Chemical equilibria in soil . USA
- 2- Sposito, G. (1989) the chemistry of soils. New York.
- 3- Sparks (1995). Environmental soil chemistry. USA
- 4- parker D. R., R.L Chaney and Norvell (1995) chemical equilibrium and reaction models. USA
- 5- Michael E. E (2003). Soil and water chemistry. New York.

6-		Lecturer's name
17. The Topics:		
Weeks	Syllabus	
1	Theory : Introduction and study the soil solid phase Practical: Introduction, course outline and main definitions	
2	Theory :Soil building minerals <ul style="list-style-type: none"> • Crystal structure – basic mineralogy • The phyllosilicates – structure and properties Practical: Soil sampling in general	
3	Theory: Soil minerals and distinguish between <ul style="list-style-type: none"> • 1:1 mineral • 2:1 mineral • 2:1:1 mineral Practical: Estimation of Electrical Conductivity (EC) of soil.	
4	Theory:- Source of negative charge in soil (soil colloid and organic matter) <ul style="list-style-type: none"> • Isomorphouse substichution • pH- dependent charge Practice:- Estimation of Soil Reaction (pH).	
5	Theory;-First examp (first hour) + Definitions of some soil chemical terms. Practice:- First exam Estimation of Total Carbonate in the soil.	
6 and 7	Theory:- Ion exchange, study the factor effecting on ion exchange and study CEC, ECEC, and ACE. Practice:- Estimation of Cation Exchange Capacity (CEC) of soil Estimation of Active Forms of Carbonate in the soil.	
8	Theory:- Study ion exchange equation and their applications <ul style="list-style-type: none"> • Freundlich equation • 2- langmair equation • 3- BET (Brunauer, Emmitt, and Teller) equation • 4- Gibbs equation Chemical equation 1- Kerr equation. 2- Vanselow equation. 3- Gapon equation. 4- Davis equation Practice:- Estimation of total nitrogen	

9	<p>Theory :-Soil solution phase study</p> <ul style="list-style-type: none"> • Soil solution characteristics • Precipitation / dissolution • Equilibrium constant <p>study and analysis some example about:-</p> <ul style="list-style-type: none"> • The low of mass action and the equilibrium constant. • Equilibrium constant and free energy relationship. • Activity and standard state. <p>Practice:- Estimation of chloride</p>	
10	<p>Theory :-Ion pair</p> <p>Practice:- Estimation of Calcium & Magnesium in the soil..</p>	
11	<p>Theory :- Second exam (first hour) + potassium chemistry</p> <p>Practice:- Second exam</p>	
12	<p>Theory:- The CO₂ – H₂O system</p> <p>Practice:- Estimation of available Phosphorus in soil.</p>	
13	<p>Theory :-Phosphorus chemistry</p> <p>Practice:- Adsorption Isotherm for Phosphorus</p>	
14	<p>Theory:-Potassium chemistry and study the effect of mineral on fixed.</p> <p>Practice: determination of Potassium</p>	

In this section the lecturer shall write titles of all topics he/she is going to give during the term. This also includes a brief description of the objectives of each topic, date and time of the lecture

Each term should include not less than 16 weeks

18. Practical Topics (if there is any)

Determine soil chemical properties:-

- 1-soil sampling
- 2-determination soil pH and limiting soil colloid charge.
- 3- calculated soil cation exchange capacity CEC
- 4-5- Determination total and active CaCO₃
- 7- Determination soil organic matter.
- 8- Determination Ca and Mg
- 9- 9-Determination K, Na and soil salinity
- 10-
- 11-Determination soil Ec.
- 12-Determination total N
- 13- Determination P
- 14-14 Determination Fe and Mn

In this section The lecturer shall write titles of all practical topics he/she is going to give during the term. This also includes a brief description of the objectives of each topic, date and time of the lecture

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19. Examinations:

Univ. of salahaddin

Soil chemistry (theory)

College of Agriculture

Soil and Water Dept

Type of Examinations

First type// Define the following:-

Zero point charge, CEC, isomorphous substitution.

Answer type 1//

- Zero point charge (**ZPC**):- surface charge is electrically neutral this point or pH value is called zero point of charge pH_0
- **Cation exchange capacity (CEC)**: The total amount of exchangeable cations that a particular material or soil can adsorb at a given pH, expressed as (meq/100g) or (cmol/Kg) the numeric expression is coincident in both unit.

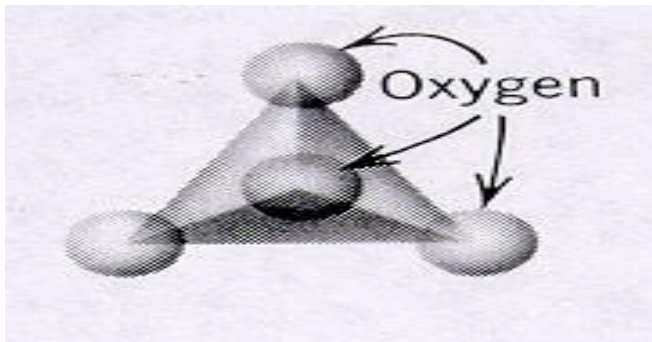
- **Isomorphous substitution is the replacement of one atom by another of similar size in a crystal lattice without changing crystal structure of the mineral.**

Type 2 // Define and demonstrated by figure the following structure of silicate minerals

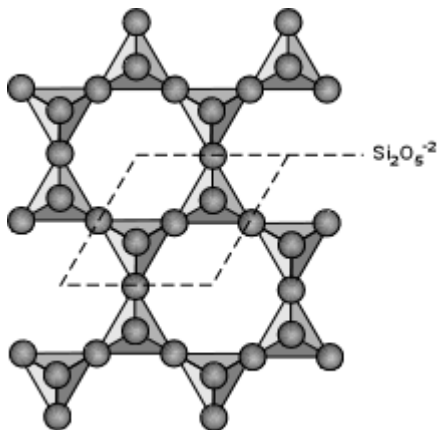
- 1- Nesosilicat
- 2- Phyllo silicates

Answer 2//

1-Nesosilicat:-single $[\text{SiO}_4]^{4-}$ tetrahedra in its structural type Si :O ratio 1:4 such as Olivine

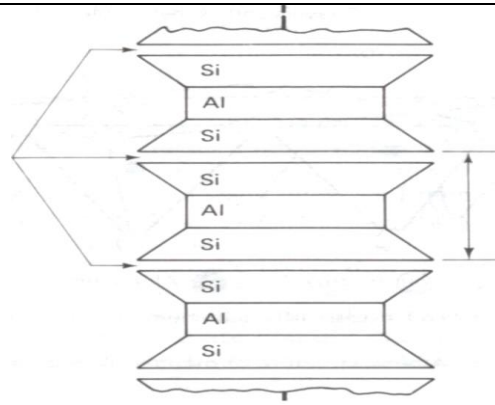


2-phylosilicates:- continuous sheets the tetrahedral sheet each sharing three oxygens Si:O ratio 2:5 $[\text{Si}_2\text{O}_5]^{2-}$ such as mica and montmorillonite



Type3//

Explain by figures the difference between 1:1 and 1:2 minerals



Type 4//: Rewrite and correct the following sentences:

- Kaolinite has pH-dependent charge and high CEC
- Micas less K and more water called montmorillinite
- Single chain is chains of tetrahedral sharing two corner and S:O is 1:3

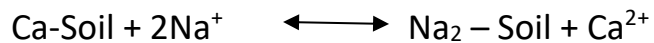
The answer:-

- Kaolinite has pH-dependent charge and low CEC
- Micas less K and more water called hydered mica (illit)
- Single chain is chains of tetrahedral sharing two corner and S:O is 4:11

Type 6// Complete the following equation and find equilibrium constant K according to Kerr equation

Ca-Soil + Na

Answer



$$[\text{Na}^+]^2 (\text{Ca}^{2+})$$

K= _____ (1)

$$[\text{Ca}^{2+}] (\text{Na}^+)^2$$

1. Compositional: In this type of exam the questions usually starts with Explain how, What are the reasons for...?, Why...?, How....?
With their typical answers
Examples should be provided

2. True or false type of exams:

In this type of exam a short sentence about a specific subject will be provided, and then students will comment on the trueness or falseness of this particular sentence. Examples should be provided

3. Multiple choices:

In this type of exam there will be a number of phrases next or below a statement, students will match the correct phrase. Examples should be provided.

20. Extra notes:

Here the lecturer shall write any note or comment that is not covered in this template and he/she wishes to enrich the course book with his/her valuable remarks.

21. Peer review

پیداچونہوہی ھاوہل

This course book has to be reviewed and signed by a peer. The peer approves the contents of your course book by writing few sentences in this section.

(A peer is person who has enough knowledge about the subject you are teaching, he/she has to be a professor, assistant professor, a lecturer or an expert in the field of your subject).