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**Department of Soil and water**

**College of Agriculture**

**University of Salahaddin**

**Subject: Soil Chemistry**

**Course Book – (Year 3)**

**Dr. Haifa Sadik Akrawi**

**Mr. Muslim Rasul Arab**

**Academic Year: 2018/2019**

**Course Book**

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| **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**](mailto:Haifa.yaseen@su.edu.krd)  **e-mail: muslim.khoshnaw@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** | **A- Theory:-**  **e.g Webpage, Blog, Moodle…**   * **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** * **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**   **B- Practice:**  **Muslim R. Arab, I have Bsc in Soil and Water Science (Salahaddin University. 2006), Msc. in Plant nutrition and Fertility (Salahaddin University. 2011) now PhD. student in salahaddin university in Soil Chemistry branch . I'm a lecturer at Soil and Water Dept. Agriculture college.**  **2002-2006 Bachelor in Science (B.Sc.) Agriculture College, Soil and Water Dept. University of Salahaddin –Erbil/Iraq.**  **2008-2010 Master of Science (M.Sc.) (plant nutrition and Fertility) University of Salahaddin –Erbil/Iraq.**  **2016 (PhD student) (Soil Chemistry) College of Agriculture, soil and water Dept. University of salahaddin, Erbil**   * **Membership** * **Member of Kurdistan Agronomist Syndicate, Erbil, Iraq. 2006** | |
| **9. Keywords** | **Soil menials, pH, Ion exchange, CEC, Soil reaction, Ion Pair ,** | |
| **10. Course overview:**  In this section the lecturer shall write an overview about the subject he/she is giving. The course overview must cover:   * **Soil Chemistry :- it is a branch of edaphology science studies mainly the reactions involved in the soil solution and the solid-liquid interface.**   **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.**  **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.**  **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**   * **Ion exchangeable:- The substitution of one ion for another on the surface or in the interstitial spaces of a crystal**   + **Cation exchange (e.g., Ca2+ for K+)**   + **Anion exchange (e.g., H2PO4- for NO3-)**   **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 equlibrium and reaction models. USA 5. Michael E. E (2003). Soil and water chemistry. New York. | | |
| **17. The Topics:** | | **Lecturer's name** |
| |  |  |  | | --- | --- | --- | | Weeks | Syllabus |  | | 1 | Theory : Introduction and study the soil solid phase  Practical: Introduction, course outline and main definitions |  | | 2 | Theory :Soil building minerals   * Crystal structure – basic mineralogy * The phyllosilicates – structure and properties   Practical: Soil sampling in general |  | | 3 | Theory: Soil minerals and distinguish between   * 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)   * 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   * 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 | Theory :-Soil solution phase study   * Soil solution characteristics * Precipitation / dissolution * Equilibrium constant   study and analysis some example about:-   * The low of mass action and the equilibrium constant. * Equilibrium constant and free energy relationship. * Activity and standard state.   Practice:- Estimation of chloride |  | | 10 | Theory :-Ion pair  Practice:- Estimation of Calcium & Magnesium in the soil.. |  | | 11 | Theory :- Second exam (first houre) + potassium chemistry  Practice:- Second exam |  | | 12 | Theory:- The CO2 – H2O system  Practice:- Estimation of available Phosphorus in soil. |  | | 13 | Theory :-Phosphorus chemistry  Practice:- Adsorption Isotherm for Phosphorus |  | | 14 | Theory:-Potassium chemistry and study the effect of mineral on fixed.  Practice: determination of Potassium |  |   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  6-Determination soil organic matter.   1. Determination Ca and Mg 2. 9-Determination K, Na and soil salinity 3. Determination soil Ec. 4. Determination total N 5. Determination P 6. 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 | |  |
| **PRACTICE QWETIONS**  **Q1/ Fill each of the following blanks :-**  **1-The chemical name of EDTA-2Na is ------------------------------------------------------------and with formula --------------------------------------------------------------------------------------**  **2- Reagents for Determination of CEC are**  **----------------------------------------------------------------------**  **--------------------------------------------------------------------------**  **---------------------------------------------------------------------------**  **------------------------------------------------------------------------------**  **3- The objective of determination active lime (active CaCO3) is**  **-------------------------------------------------------------------------------------------**  **--------------------------------------------------------------------------------------------**  **ANSWER**  **Ethylene Damien tetra acetic acid disodium**  formula  **Na-OOC-CH2 CH2-COO-Na**  **N-CH2-CH2-N**  **HOOC-CH2**  **CH2-COOH**  2-   1. **1 *N* CH3COONa (pH…8.2).** 2. **1 *N* CH3COONH4 (pH….7).** 3. **99% Isopropyl alcohol.** 4. **1000 ppm Na solution to preparer (0, 5, 10, 15 and 20 ppm) Na solution.**   3-  *1-For calculating the ratio between active and total lime (active/total lime)*  *2-the active lime regards as a best indicate for limiting nutrient status and fertilizer recommendation.*  Q2/What is the principle of determination of active carbonates?  ***Answer***  *The more active and mobile from of soil carbonates are extracted during this reaction**.*  *Active carbonates react rapidly with ammonium oxalate to form insoluble calcium oxalate*  *(NH4)2C2O4+CaCO3 CaC2O4+ (NH4)2CO3*  *And the excess oxalate (NH4)2 C2O4 can be titrated with potassium permanganate (with a known normality) in acidic medium due to the following equation.*  *5(NH4)2C2O4+2KMnO4+8H2SO4 2MnSO4+K2SO4+10CO2+5(NH4)2SO4+8H2O*  Q3/Correct the following EC meter reading EC =4.1 dSm-1 at temperature = 95Fo. and EC=3.8dSm-1 at temperature = 59Fo  If you know that Fo = 1.8 Co +32  Answer  95 = 1.8 Co +32 1.8Co=95-32=63 Co=63/1.8=35  More than 25 Co 35-25=10  10\*0.02=0.2  EC =4.1-0.2=3.9 dSm-1 .at 95Fo  59 = 1.8 Co +32 1.8Co=59-32=27 Co=27/1.8=15  Less than 25 Co 25-15=10  10\*0.02=0.2  EC =3.8+0.2=4.0 dSm-1 .at 54 Fo  Q5/A-Explain the effect of pH on availability of nutrient in the soil .  B/  about **7 g** soil sample from Grdarasha is taken, and placed in **250 ml** conical flask, then **40 ml** of **1N HCl** was added after shaking for **2h** and faltering, the **8 ml** of aliquot is tacked, and after adding **3drops** of ph.ph indicator to it, titrated with **1N NaOH** by adding **6ml** gives pink color, then calculate **Total Lime** in this soil.  /A  effected pH on availability of nutrient in the soil, pH effect on phosphrs in to the soil solution the mole fraction of (H2PO4) and (HPO4) depends on pH, at 7.2 the amount of H2PO4 is equal to the amount of HPO4, thes phases are availabile for uptake by plant root, whiel H3PO4 and PO4 is increase when change of pH value.  Bl  HCl NaOH  8 6  40 X  X= (40\*6) /8 = 30ml NaOH  %CaCO3 = (mlHCl \* NHCl) –( mlNaOH \* N NaOH) \*5/wt of sample.  (40\*1) – (30\*1)\* 5/7 = 7.14%\ | | |
| **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 پێداچوونه‌وه‌ی هاوه‌ڵ**  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).* | | |