EFFECT OF PLANT COVERAGE ON MINERALOGICAL CHANGES OF MICA IN RHIZOSPHERE

B.O. Al- Jaff
Assist.Prof.
Techn. Instit.
Polyt. University of Sulaimania - Chamchamal

S. K. Essa
Prof.
University of Baghdad
College of Agricultural Engineering

ABSTRACT

Three soil sites were chosen in sulaymaniyah governorate, for three types of trees (pine, oak and pear), in order to study the effect of biochemical activities in rhizosphere on weathering of mica and potassium availability comparing with Bulk soil. Results of X-ray showed that the transformation process of mica to 2:1 expandable minerals in rhizosphere was exceeded than in Bulk soil of all type of trees. While the superiority of mica weathering, and increase of smectite content in all rhizosphere were taken a followed sequence. Pine > oak > pear. Results of SEM for clay samples of Bulk soil showed there was no cracks, splitting, Exfoliation, and no separation of the layers on the surfaces of minerals. While the inspection results confirmed two types of mica edges weathering: first, was a complete edge weathering of mica in Bulk soil of pine trees, and second, was un completed edge weathering in Bulk soil of oak and pear. Also a complete pal colour of mica particle surfaces were found in clay samples of rhizosphere soil under pine trees. While the surfaces and edges of mica were less affected by the weathering processes, was found in clay samples of rhizosphere soil of oke and pear trees.

Key words: biochemical activities, weathering, potassium.

تأثير الغطاء النباتي في التغيرات المعدنية للمايكا في منطقة الرايزوسفير

بـــارزان عمـــر الجـــاف
المعــهد التقنــي فـي جمـجمـال
جـامعـة السليمانيــة التقنيـة

سلمـــان خلـف عيـسى
كلية علوم الهندسة الزراعية
جـامعـة بغـداد

المستخلـص

اختيرت ثلاثة مواقع لترب تحت اشجار الصنوبر ، البلوط ، والعرموط البري ضمن محافظة السليمانية ، لدراسة تأثير الانشطة الكيموحيوية ضمن منطقة الرايزوسفير في تجوية معادن المايكا وجاهزية البوتاسيوم مقارنة مع كتلة التربة. اظهرت فحوصات الاشعة السينية الحائدة X– ray تفوق عملية تحول معادن المايكا الى معادن 2:1 المتمددة ضمن الرايزوسفير مقارنة بكتلة التربة وتحت انواع الاشجار جميعها، في حين اتخذت عملية تجوية المايكا وارتفاع محتوى معادن السمكتايت في منطقة الرايزوسفير التتابع الاتي: اشجار الصنوبر > اشجار البلوط < اشجار العرموط.بينت نتائج الفحوصات بالمجهر الالكتروني الماسح SEM ولدقائق مفصول الطين ضمن كتلة التربة عدم وجود شقوق، تقشير، او انفصال للطبقات عند سطوح معادن المايكا، في حين اظهرت النتائج وجود نوعين من تجوية حواف معادن المايكا، الاول هو تجوية حواف دقائق المعدن بالكامل وجد ضمن كتلة التربة تحت اشجار الصنوبر، والنوع الثاني هو عدم اكتمال تجوية حواف المعدن وجد ضمن كتلة التربة تحت اشجار البلوط والعرموط البري. كذلك اظهرت النتائج وجود الدقائق الباهتة اللون بالكامل ضمن منطقة الرايزوسفير تحت اشجار الصنوبر، في حين كانت دقائق المعدن اقل تاثرا بعمليات التجوية ضمن منطقة الرايزوسفير تحت اشجار البلوط والعرموط البري.

الكلمات المفتاحية: الكيمياء الحيوية، بوتاسيوم، معادن ، صنوبر ، بلوط.

***Received:12/9/2019, Accepted:11/12/2019**

INTRODUCTION

The Properties of soil in rhizospher are known to be influenced by the presence and activity of the roots which include acidification through proton extrusion and the release of root exudates (4 , 5, 11, 12). Currently little information is available on the mica weathering by the rhizospheric microorganism activity, which has mechanisms of the K– Solubilization by production of organic acids to provide potassium nutrients as well as others nutrients for enhancing of crop growth. In general, potassium release from mica structure was affected by PH, oxygen, and the bacterial strains used.(Sheikh-Abdullah and Essa)(7) found that Potassium release from the minerals was affected by PH, oxygen, and microorganism activity. The efficiency of the potassium Solubilization by different microorganisms was found to vary with the nature of potassium bearing minerals and aerobic conditions (8, 13, 14). There is paucity of information on the influence of tree species on rhizosphere soil properties generally, and from available literature,a few studies have been carried out ascertain the influence of forest trees on rhizosphere soil properties, and compare the influence of exotic and indigenous of these trees on mica transformation to 2:1 exbandable minerals. The aim of this study was to assess effect of plant coverage on mica weathering in rhizosphere comparing with Bulk soil.

MATERIAL AND METHODS

Three soil sites were chosen in sulaymaniyah governorate for three tree species including (pine, oak, and pear) considering their age (more than 30 years). Soils were characterized by similar texture, parent material, topography, climatic conditions and equal rainfall, in order to avoid any variation in soil sampling. Soils surrounding the roots under each type of tree representing rhizosphere were taken using method of (2) while a soil samples representing a bulk soil were taken at a distance of 50 cm away from rhizosphere. Soil samples were air-dried, ground, and passed through a 2- mm sieve. Some of the physical and chemical characteritics of the soils under investigation are listed in Table 1. The analyses of the soil were carriedout by using standard methods outlined by (Chima et al)(2). For mineralogical investigation soil samples were treated with NaOAc (PH 5.2) to remove calcium carbonate, and with NaOcl (PH 9.5) to remove organic matter, also the R_2O_3 were removed from soil by using DCB method of (Mehra and Jackson) (6). Then sand fractions were separated from soils by washing them on a (53 μ_m) sieve. Finally, the clay fraction was separated from silt according to stock law. The mineralogy of clay fraction was determined by X-ray diffraction (XRD). Oriented slides were prepared for both K and Mg – saturated samples. The Mg – saturated slides were solvated with ethylene glycol (EG), while the K – saturated samples were heated at 350 and 550 ^{O}C. Clay particles from rhizosphere and bulk soil were examined by scanning electron microscope. The SEM used was an INSPECT S 50. Accelexating voltages of 5 and 20kv were used for examining the edges and the (001) surfaces of mica flakes, respectively.

RESULTS AND DISCUSSION

Physical and chemical properties of studied soils: The only two physical properties of soil examiend for bouth of rhizosphere and bulk soil are soil particale size distribution and bulk soil density (Table 1). There was no significant difference in the mean values of sand, silt and clay between rhizosphere of the three tree species and that of bulk soil. The amount of silt was observed to be highest in both of rhizosphere and bulk soil. Also the results of Table 1 showed there was a high convergence in values of bulk density in all studied soils. Results in Table 1 show that the PH of all rhizospheres of different tree species was slightly lower compared to bulk soil, this attributed probably to the soil acidification by trees to the release of H^+ ions from plant roots and microorganisms respiration or the release of acidic exudates in the rhizosphere soil.

Mineralogical changes

The identification and dominance of 14 A^o and 10 A^o clay mineral peaks in rhizospheres and bulk soils were depended on d – spacing and peak height. The 14 A^o (2:1 expandable minerals) were identified from 14 A^o peak in Mg-saturated air-dry treatment, and expanded to 17 A^o in ethylene glycol – saturation, and disappear in K-saturation 350 C^o , which confirms the presence of smectite minerals. Mica minerals were identified by 10 A^o

reflection, and it remains the same in all treatments (Fig 1). Two types of interstratified minerals (Regular and irregular) were identified in studied soils.The 14 A^o peaks were observed in all rhizosphere and bulk soils, but in different intensity. Results in Fig 1 show that the 14 A^o peak had a greater intensity in all rhizosphere soils than in the bulk soils.=

Table 1. Some physical and chemical properties of studied soils

Tree	B.D	Sand	silt	clay	PH	O.M	T. $CaCO_3$	A.$CaCO_3$
		g.kg $^{-1}$						g.kg $^{-1}$
Pine	1.21	346.35	384.31	269.34	7.18	39.17	266.94	170.42
B.Soil	1.32	379.89	377.43	242.71	7.31	20.11	254.62	127.73
Oak	1.11	400.06	351.42	248.52	7.28	31.17	236.32	97.18
B.soil	1.22	411.32	337.53	251.15	7.36	27.20	214.15	86.27
Pear	1.23	239.26	389.50	371.24	7.37	36.15	287.54	131.35
B.soil	1.31	251.78	381.72	366.50	7.46	19.50	274.44	129.11

Results in Fig 1 show that the relative intensities of 14 A^o and also interstratified mineral peaks for the rhizosphere soil under pine trees are higher than those for the rhizosphere soils of oak and pear. X- ray diffraction diagrams (Fig1) show a mineralogical transformation of mica into the interstratified minerals, and 2:1 expandable minerals (smectite), this transformation was observed in all rhizosphere soils and was greater in pine rhizosphere than in oak and pine rhizospheres. The greater transformation of mica in pine rhizosphere, which could be explained by the greater amount of organic acids released into the rhizosphere by roots (Table 2). AL- Jibury (1) has observed that plant roots are responsible for substantial changes of rhizosphere PH. These changes are take place by several michanisums, one of them, roots release protons in order to maintain their change balance whenever they take up more cations than anions and take up protons in the opposite case (10, 15). Another biological function of roots that can affect the rhizosphere PH is the respiration of both roots and rhizosphere microorganisms. Whatever the origin of the changes in rhizosphere PH, the corresponding increase or decrease of proton concentration will promote the dissolution of mica minerals. According to these findings, we can determine the intensity of mica weathering and its transformation to interstratified minerals or to 14 A^o expandable minerals in rhizosphere and bulk soils.We used three indicators to express these findings, first the intensity of peak in Mg-saturation air dry treatment, which expresses the degree of dominance of each mineral, second the d-spacing of peak, which is consider a clear indicator for weathering stage, and third focusing on the type of interstratified mineral, which is a product of transformation of mica to 2:1 expandable minerals process and shows the position of mineral along way of the transformation chain, supporting that the contribution ratio of mica or expandable minerals in the structure of interstratified mineral (Table 3). So the results in Fig1 show the sequence of peak intensity for smectite mineral in rhizosphere soils of pine, oak, and pear trees. Also, results showed that the amount of smectite in rhizosphere soils of three species was took the following sequence: Pine >oak > pear The above sequence indicates an increase of smectite mineral in rhizosphere soil of pine, which reflects the increased transformation of mica towards 2:1 exandable minerals.

Table 2. Humic acid, contains in studied soils

	Rhizosphere			Bulk soil		
Tree	HA	FA	Hu.	HA	FA	Hu
		g.kg $^{-1}$			g.kg $^{-1}$	
Pin	0.872	0.210	2.31	0.451	0.172	1.420
Oak	0.422	0.170	1.57	0.220	0.113	0.873
Pear	0.335	0.110	1.42	0.153	0.101	0.621

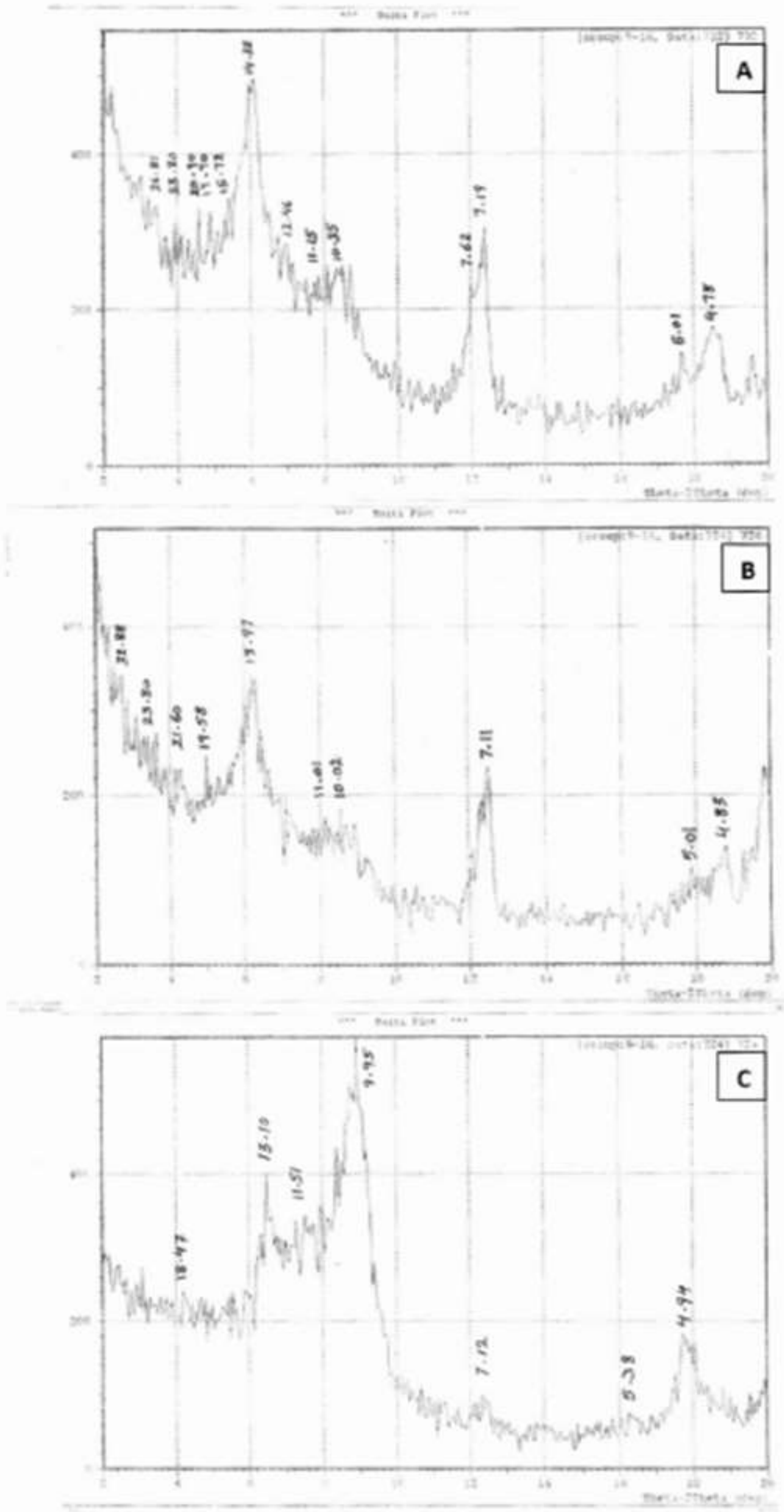

Figure 1: X-ray diffraction patterns of Mg-saturated (air day) clay fraction from rhizosphere of A: Marus Albd, B: phoenix Dactylifera, C: Citrus Aurantium.

Table 3. Characteristics of peak in clay samples from rhizosphere of trees in Mg – saturated air – dry treatment.

sample	IS / IM	S – ds A^O	M – ds A^O	Inter.	Inter. S	Inter. M	Inter. S/M
Pine	8.12	14.38	10.35	S - M	62	38	1.63
Oak	5	13.97	10.02	M - S	40	60	0.66
Pear	3.5	13.10	9.95	M - S	23	77	0.29

Is: peak intensity of smectite **IM**: peak intensity of mica
S: smectite **M**: Mica **Inter**: Interstratified minerals **ds**: d - spacing

Scanning electron microscope inspection (SEM).

Morphological features of mica particles from rhizosphere and bulk soils were inspected by SEM. Results of SEM for mica clay sample of bulk soils under three species Fig 2 a,b show no cracks, splitting, exfoliation, and no separation of the layers on the surfaces of particles. Also the inspection results confirmed two types of mica edges weathering : first, was a complete edge weathering of mica found in bulk soil of pine trees (Fig2d) and seconed, was uncompleted edge weathering in bulk soil of oak and pear trees (Fig2c). Essa and Majied (3) have found the same morphological features for mica particles in some Iraqi soils, and attribute that to low intensity of mica weathering in these soils. Results of SEM for mica clay samples of rhizosphere soils were revealed three types of morphological features: first, a complete pal colour of mica particle surfaces, which found in clay samples of rhizosphere soil under pine trees (Fig2e), seconed pattern appear as dark spots midst of pale colour of particle with different sizes represent the core of mica (Fig2f). These features were also found in clay samples of rhizosphere soil of pine trees. These features suggest that the rate of replacement of interlayer K would, most probably and agree with findings of our studies (3,7). The thired pattern was found in the clay samples of rhizosphere soil of oke and pear trees (Fig2d), the surfaces and edges of mica were less affected by the weathering processes, and the edges weathering was identified with different thickness of weathered edges related to the intensity of weathering that were exposed. In general the results indicated, the importance of plant root in controlling the soil chemistry and hence the clay mineralogy of rhizosphere soil. The results indicated that the properties of soil in the rhizosphere were influenced by the presence and activity of the roots which include acidification through proton extrusion and the release of root exudates, which is modifies the mica structure differently in rhizosphere compared to the bulk soil, and suggest that some morphological features changing to the mica particles in rhizosphere of different tree species.

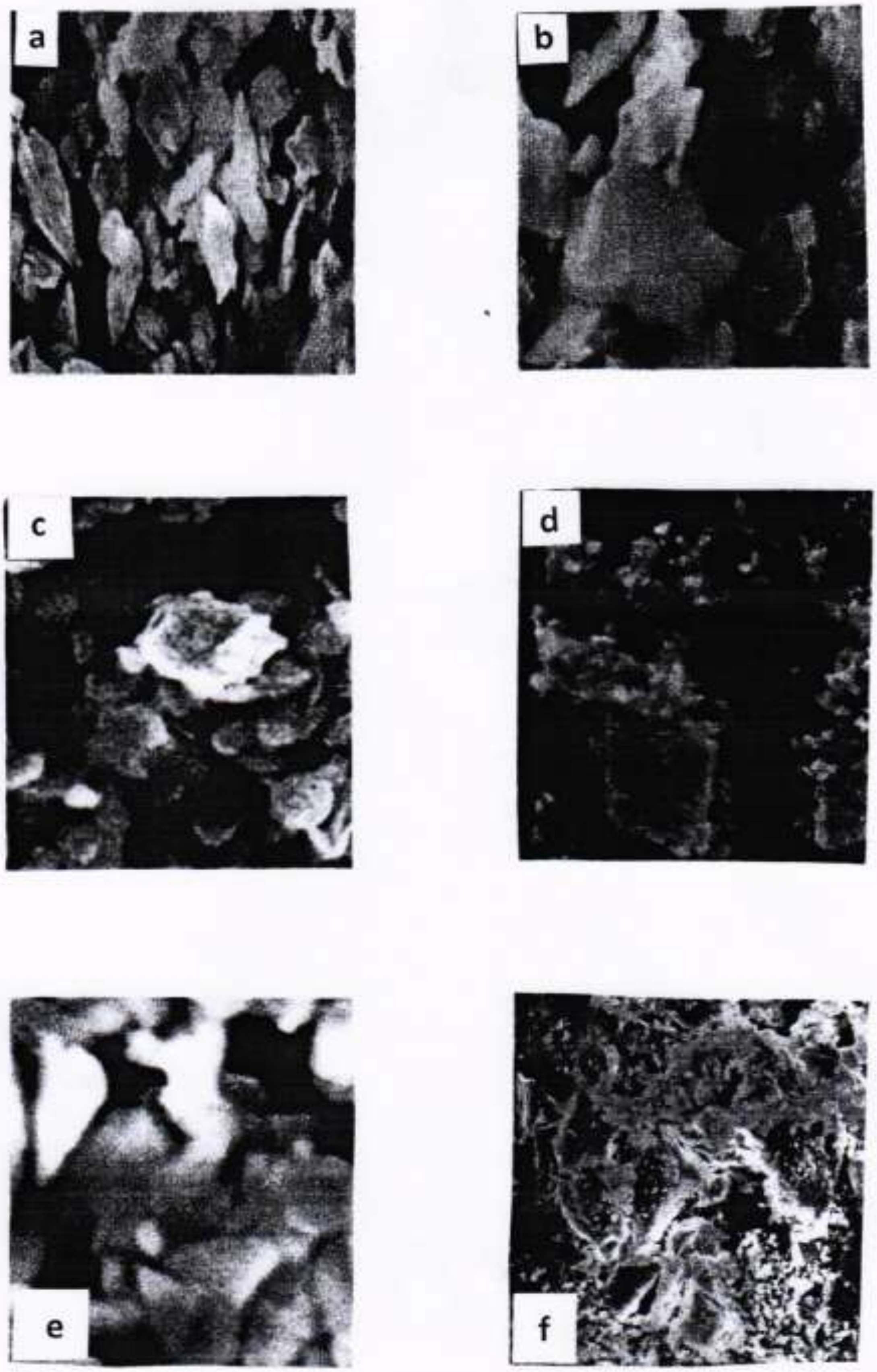

Figure 2: SEM images for mica particles : a,b-the (001) Surface of mica particles in bulk soils ;c- uncompleted edge weathering ;d- completed edge weathering ; e,f layer weathering of mica particles in rhizospher of pine tree .

REFERENCES

1. AL – jibury. S.S. 2017. The Effect of Sediments Type on Properties and Content of Mica and Potassium Availability in Some Soils of Mesopotamian Plain. MS.C Tesis, College of Agricultural Engineering Sciences – Univ. of Baghdad

2. Chima, U.D., E.F. Akabue, and I.R. Gideon. 2016. Rhizosphere soil properties and growth attributes of four tree species in a four-year a rboretum at the University of Port Harcourt, Nigeria. Nigerian Journal of Agriculture, Food and Environment 12 (2) 47-80

3. Essa.S.K., S.S.Majied.2018. Effect of sediments source on morphological features of mica and potassium availability in some soils of mesopotamian plain. Iraqi. J. of Agri Sci: 23 (1).

4. Grayston .S.J. , D.vaughan and D. Jones. 1996. Rhizosphere carbon flow in tree, in comparison to annual plants: The importance of root exudation and its impact on microbial activity and nutrient availability. App. soil Ecol.

5. Jones.D.L., C. Nguyen and R.D. Finlay-2009. Carbon Flow in the Rhizosphere :Carbon Trading at the soil – Root Interface Plant and Soil 321 (1-2): 5 – 33.

6. Mehra, C.P. and M.L. Jackson. 1960. Iron oxide removal from soils and clays by a dithonite citrate system buffered with sodium bicarbonate Clay and clay Miner., 7:317-327.

7. Sheikh – Abdullah.S.M. and S.K.Essa. The morphological features of mica and chlorite minerals in fine sand fraction is some forest soils in sulaymaniyah Governorate, Kurdistan Inter.J.of plant, Animal and Enviro. Sci. vol.5, Issue,2 : 97-104.

8. Sheng. X.F. and HW. Yuang .2002 Mechanism of potassium release from feldspar affected by the strain NBT of silicate bacterium – Acta pedol. Sin ., 39: 863-871

9. Uroz.S.,C. Christophe., M. Turpauit., P. Frey – Klett 2009. Mineral weathering by bacteria: ecology, actors and mechanisms Trends in Microbiology 17 (8) : 378 – 387.

10. Van Hees, p. A. W, D. L. Jones and D.L. Godbold 2002. Biodegradation of low molecular weigh organic acid in coniferous forest podzolic soils. Soil Biology and Biochemistry, 34:1261-1272.

11. Wang, Z., A. Gottlein and G. Bartonek. 2001. Effect of growing roots of picea abies L. karast and European beech (Fagus Sylvatica L. Karast) on Soil Solution Chemistry. J. of plant nutrition and soil science.

12. Wang, X., Q. Li. Hu., T. Zhang and Y. Zhou. 2005. Dissolution of kaolinite induced by citric, oxalic and malic acids. J. of colloid and interface, 290:481-488.

13. Welch, S. A., A. E. Taunton and J. F. Banfield. 2002. Effect of microorganisms and microbial metabolites on apatite dissolution. Geomicrobiology Journal, 19:343-367.

14. Young, I. M. 1995. Variation in moisture contents between bulk soil and the rhizosheath of wheat (*Triticum aestivum* L. CV. Wembley) New Phytologist. 130, 135-139.

15. Youry, P., T. Mimmo., N. Tomasi., R. Terzano., S. Cesco., and C. Crecchio. 2015. Microbial interactions in the rhizosphere: beneficial influences of plant growth promoting rhizobacteria on nutrient acquisition process. Areview 2015. Biol Fertil soils 51: 403-415.