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Research Article

VEGETATION EFFECTS ON MICRO-MORPHOLOGICAL PROPERTIES OF CALCAREOUS SOILS: A CASE STUDY IN KHAJEH REGION, EAST-AZERBAIJAN PROVINCE, IRAN

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ABSTRACT
It seems necessary to study the vegetation effects micro-morphologically as a soil forming factor. In this study, the micro-morphological properties of profiles from the soils of Khajeh region under the use of watermelon, peas, barley, and a control profile were dug and described. The findings showed that due to cultivation in these soils most of the voids are vugh and plane. The structure in the surface horizons of cultivated profiles is granule, but in the non-cultivated profiles is complex. Despite the calcareousness of profiles, clay coatings were observable in profile 4, which is an evidence for clay transition in a climate other than the current climate, related to past climate. The presence of iron and manganese nodules in the second and third horizons of profile 2, considering the low levels of ground water in that unit, is due to flood irrigation system. Crystallitic birefrence-fabric is one of the outstanding characteristics of Calcic and gypsic, but in some horizons speckled b-fabric is dominant; the reason for this can be due to the dominance of clay over calcite and its stipple and non-uniform distribution in horizon. In comparison to the lower horizons of each profile, pedality is high in surface horizons and observing enaulic distribution pattern in surface horizons confirms this phenomenon. The amount of pedality in the surface horizons of profiles had an ascending order from control, peas, barley, and watermelon respectively. Also, related distribution pattern within coarse and fine particles in the lower horizons of all profiles is due to the fine texture of soils, porphyric types.

***Keywords**: Calcareous soils, Khajeh, micro-morphology, Vegetation*

INTRODUCTION
Land use can impact on the micro-morphologic properties of soil including birefrence-fabric, microstructure (type, pore size and structure), related distribution pattern within coarse and fine particles and shape or form of pedofeatures. Therefore, it seems necessary to study the vegetation effects micro-morphologically as a soil forming factor. Different uses and severe cultivations due to changing soil pores and distributing their size can lead to the demolition of soil structure and even the decrease of lands' performance. Kapur *et al.,* (2007) studied the changes in the shape, porosity and aggregate in micro level and explained the development mechanism of soil microstructure under different uses. Moreover, changes in land use and cultivation type can impact on the size, shape, connection types of voids and finally on the soil microstructure (Kilfeather and Vander Meer, 2008). Also, land use and management practices can impact on the biological activities of soil as well as the size and shape of bio-pore (pores larger than 1000 m), which are important in water movement and root development (Lee, 1985). In 1995, Sveistrup *et al.*, by studying the surface horizons of farming and forest soils showed that the cultivation cause great changes in microstructure. Phillips and Fitzpatrick (1999) studied the role of vegetation and soil fauna on the formation some soils. To do this, they conducted morphological, micro-morphological, organic carbon and organic matter studies on six spodosol profiles and entisol profile in America East & North East of Scotland. They concluded that the humification of plants remains by fungi and soil fauna is seen in all organic horizons. Also, they studied the thin section and showed that the maximum accumulation of roots' material is seen in various decomposition stages in spodic horizon of spodosol soils. Rezai *et al.*, (2013) by studying the effects of vegetation on the micro-morphological properties of soil concluded that the surface horizons of profiles in comparison to lower horizon shave an ideal situation concerning

structure and pedality. Also, the amount of pedality and the improvement of soil structure for different coatings were as apple orchards, pine trees, corn, alfalfa, rapeseed and control respectively. Kaslakheh *et al.*, (2012) observed that the uncovered soil had a weak and massive microstructure, but soils covered with lichen had porous granule and blocky angular structure. The soils covered with lichen showed two types of crystallitic b-fabric and speckled, while in the soils without lichen covering b-fabric is mainly crystallitic. Kodesova *et al.*, (2007) by studying the micro-morphology of two organic horizons under spruce forest and grass vegetation concluded that the decomposed organic matter in organic horizon under grass vegetation is more compact compared to spruce forest**.** Samaya *et al.*, (2000) stated that the micro-morphology is used as an important and essential supplement to help us understand the biological and geophysical contacts of steeped lands and the effects of land use management on soil consistency. In this study, the effects of different uses such as watermelon, peas and barley are examined on the micro-morphological properties of soil.

MATERIALS AND METHODS

This study was conducted on calcareous soils of Khajeh region which is located in the northeast of East-Azerbaijan Province. Soils of this region have aridic border to xeric moisture regime and mesic temperature regime (Ebadpour, 2000). To achieve the desired objectives, four profiles under different uses such as watermelon, peas, barley and a control profile (non- cultivated) were dug and described by the use of geological and topographic maps of the region and preliminary studies. The studied profiles were classified based on American Classification key (Anonymous, 2010) in the category of aridisols. Then the chemical and physical studies were done on distributed samples and also undisturbed samples were taken for micro-morphological studies.

Physical and chemical experiments:

To do physical and chemical experiments, the samples were air dried and then were sieved by a 2 mm sieve. physical experiments included soil texture by hydrometer method (Gee and Bauder, 1985) and chimerical experiments included pH or soil reaction in paste-saturated(Anonymous, 1954), the electrical conductivity of the saturated extract (Anonymous, 1992), cation exchangeable capacity by sodium oxalate method in pH = 8.2 (Sayegh *et al.*, 1978), calcium carbonate equivalent to titration method (Anonymous, 1992), organic carbon by Walkley and Black method modified by Nelson and Sommers (1982), the percentage of gypsum by Aston method (Anonymous, 1992).

Micro-morphological experiments:

Undisturbed samples were placed in air exposure to be dried. Then to prepare thin sections, samples were impregnated with a mixture of resin vestapol-H by a proportion 9 to 1, and 12 drops of cobalt-octat hardenerand 24 drops of cyclohexane-peroxide.

Eventually, the thin sections were prepared with a thickness of about 30 micrometers for micro-morphological studies. The descriptionof thin section was done by polarized microscope according to the instructions provided by Bullock *et al.*, (1985) and Stoops(2003).

RESULTS AND DISCUSSION

The morphological characteristics and the physical and chemical properties of studied profiles are given in Tables 1 and 2. The description of thin sections based on the description guide of Stoops(2003) and Bullock et al. (1985) is presented in Table 3.

In comparison to the lower horizons of each profile, pedality is high in surface horizons. Observing enaulic distribution pattern in surface horizons confirms this phenomenon. Moreover, the study of Servati *et al.*, (2011) presented similar results.

The amount of pedality in the surface horizons of profiles had an ascending order from control, peas, barley, and watermelon respectively. In the cultivation of watermelon, heavy and multiple-step plough is not done, which might be a reason for proper structure of the surface horizons of this profile. The reason for better structure of barley in comparison to control and pea is that barley has more root exudates due to being gramineae. Pea also has a better structure in comparison to control.

The related distribution pattern within fine and coarse particles (c / f) in the lower horizons of all profiles is Porphyric. Stoops (2003) attributed the Porphyric distribution pattern to the fine textures of soil and the textures obtained from chemical and physical experiments confirm this. In this evaluation the limit of 20 microns is considered for particles.

The morphological observations of these soils suggest that due to the cultivation, most of the voids are among vugh and plane types(Figure 1a and1b). Prado *et al.,* (2009) and Vera *et al.,* (2007) reported that more soil tillage operations cause the destruction of channel voids and their change into vugh and plane voids.

The microstructure in the surface horizons of cultivated profiles is granular but in non-cultivated profiles is angular blocky and granular(Figure 1c and 1d). Stoops (2003) relates the presence of such structures in soil with biological activities.

Therefore, it can be concluded that vegetation cause the change of soil structure. It also creates consistent structures in the surface of soil. Moreover, Stoops (2003) reported the presence of granular structure along with developed vugh pores as the properties of developed and consistent soils.

The presence of iron and manganese nodules in the second and third horizons of profile 2, considering the low levels of ground water in that unit, is due to flood irrigation system (Figure 1e and 1f). It is worth to note that due to soil disruption in the first horizon of this profile, iron and manganese nodules were not observed.

Crystallitic b-fabric is one of the outstanding properties of Calcic and gypsic profiles (Jafarzadeh, 1991). However, in some horizons speckled b-fabric is more dominant; the reason for this can be due to the dominance of clay over calcite and its stipple and non-uniform distribution in horizon (Figure 1g,1h and 1i).

Despite the calcareousness of profiles, clay coatings were observable in profile 4 (Figure 1j). Abdolvahabi (1995) considered the calcite as a barrier to the transmission of clay. According to him, maybe the reason for the lack of clay coatings is due to the presence of calcite which prevents us to observe clay. The lack of clay films in most of in arid and semiarid regions is due to the accumulation of pedo-carbonates (Gile and Grossman, 1968, 1983; Aguilar *et al.,* 1983; Pal et al. 2003).

But Jafarzadeh (1988) reported that the transmission of clay is possible even in the presence of calcite. Khademi and Mermut (2003) consider the presence of clay coatings in the thin sections of soil as an evidence for clay accumulation and state that the adequate rainfall in the humid climate of past caused the movement of carbonates from surface soil, the subsequent leaching of clay and the formation of argilic horizon in soil.

The presence of clay coatings in this profile is an evidence for clay transmission in a climate other than the current climate, related to past climate.

Accumulation of calcium carbonate can be occurred as nodules, too. These nodules were observed in profile 2 (Figure 1k and 1l). Seghal and Stoops (1972) reported that, in relation to the role of plants and organisms, these pedo-features are formed due to the production of carbon dioxide in result of respiration and the wetness and dryness of soil's fabric.

Mahmoodabadi and Khormali (2011) stated that in the natural condition of forest soil, carbonate compounds are accumulated in various forms such as nodules due to the consistency of lands and the infiltration of water in soil. In general, the situation is completely prepared for their growth and development. But in farming soil condition compared to natural soil condition, the permeability of soil is decreased and the accumulation of carbonate compounds and the formation of these pedogenic factors are prevented due to various reasons, including the use of agricultural machinery and compaction of the soil as well as the absence of permanent vegetation.

Table 1: Soil morphological properties in studied profiles

Horizon	Depth(cm)	Color moist	Structure	Pores	root	Carbonate	Clay coatings
Profile1(watermelon land use): 38° 07′ 37.3"N.Lat. 46° 37′ 53.3"E.Long.							
Apyz	0-20	10 YR 5/2	1fgr	1vfTU	2vcC	-	-
Bkyz1	20-47	10 YR 4/3	2fsbk	2fTE	2fT	K2f3	-
Bkyz2	47-70	10 YR 4/3	3msbk	2mTE	-	K2f3	-
Bkz	70-120	7.5 YR 5/3	2mabk	2mTE	-	K2c4	-
BC	120-153	5 YR4/4	1Cabk	1coTE	-	-	-
Profile2(Pea land use): 38°10′ 19.3" N.Lat.46°40′ 39.3"E.Long.							
Ap	0-20	10 Y 5/2	3mgr	3mTE	3mC	-	-
Bkyz1	20-41	7.5 YR 5/2	2fsbk	2fTE	3mT	C3f2	-
Bkyz2	41-89	10 YR 6/1	2fsbk	2fTE	2fT	C3m2	-
Bkyz3	89-123	10 YR 6/1	1fsbk	1vfTE	1coP	C3m3	-
BC	123-154	10 YR 5/2	1fsbk	1vfTE	-	-	-
Profile3(Barley land use): 38° 09′ 14.5"N.Lat. 46°43′ 24.9"E.Long.							
Apz	0-18	10 YR 4/4	1vfabk	2VfTE	3coT	-	-
Bkyz1	18-41	10 YR 4/2	2mabk	2fTE	2mT	C3f1	-
Bkyz2	41-89	10 YR 6/3	2mabk	2fTE	2mT	C2m1	-
Bkz1	89-117	10 YR 5/3	1mabk	2mTE	1mP	-	-
Bkz2	117-150	7.5 YR 5/3	1mabk	1vfIG	1vcC	-	-
Profile4(Non-cultivated): 38° 09′ 14.5"N.Lat. 46°40′ 39.3"E.Long.							
Ap	0-20	10 YR 5/2	2mabk	3mTE	2mC	-	-
Btkz1	20-59	10 YR 5/3	3Cabk	2fTE	2mP	K2c3	TfDFP
Btkz2	59-86	10 YR 5/3	3Vcabk	3mTE	2mP	K2c3	TfDFP
Bkz	86-106	10 YR 5/3	2Vcabk	2mTE	-	K2m4	-
Bk	106-146	10 YR 4/3	1Vcabk	1mTE	-	K2m2	-

Table 2: Soil physico-chemical properties in studied profiles

Horizon	Texture	CCE(%)	OC(%)	EC_e(dS/m)	pH	CEC (meq/100gr)	GYP(%)
Profile1(watermelon land use):Fine, mixed, active, mesic, Calcic Haplosalid							
Apyz	CL	13.9	0.72	5.25	7.51	17.60	14.1
Bkyz1	CL	17.4	0.44	11.22	7.49	16.80	13.2
Bkyz2	CL	17.2	0.31	19.18	7.64	13.90	11.4
Bkz	C	18.1	0.23	37.34	7.95	21.10	5.4
BC	C	7.4	0.10	68.44	8.04	19.40	6.2
Profile2(Pea land use): Fine loamy, mixed, active, mesic, petronodic Xeric Calcigysid							
Ap	SCL	12.3	0.83	2.90	7.73	22.67	2.7
Bkyz1	CL	19.3	0.63	8.11	7.81	23.04	5.9
Bkyz2	SCL	21.1	0.44	11.00	7.67	18.92	16.4
Bkyz3	SCL	25.6	0.23	13.41	8.09	14.23	17.1
BC	C	21.8	0.10	14.07	7.69	15.23	8.4
Profile3(Barley land use): Fine loamy, mixed, active, mesic, Xeric Haplocalcid							
Apz	L	10.8	1.11	1.27	7.32	22.98	3.4
Bkyz1	SiCL	15.6	0.83	15.33	7.47	16.21	7.5
Bkyz2	L	13.9	0.72	20.90	7.40	13.50	11.9
Bkz1	L	15.7	0.52	22.00	7.51	10.30	4.3
Bkz2	SL	19.9	0.23	25.80	7.85	8.70	3.6
Profile4(Non-cultivated): Fine, mixed, active, mesic, Xeric Calciargid							
Ap	CL	11.7	0.72	2.60	7.18	15.43	1.1
Btkz1	CL	14.1	0.44	4.96	7.45	17.11	0.7
Btkz2	SiCL	16.9	0.23	4.59	8.21	15.43	2.1
Bkz	CL	18.1	0.31	4.27	7.58	16.29	2.2
Bk	C	22.2	0.23	4.50	7.51	13.87	1.2

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Table 3: Soil micromorphological properties in studied profiles

Horizon	Voids-microstructure	c/f related distribution	b-fabric	Pedofeatures
Profile1(watermelon land use)				
Apyz	Compound Packing – granular	Enaulic	Mosaic-speckled	-
Bkyz1	Vugh-Moderately developed angular blocky	Porphyric	Mosaic-speckled, Crystallitic	-
Bkyz2	Vugh-Moderately developed angular blocky	Porphyric	Crystallitic, Speckled	Gypsum crystals-Acicular calcite
Bkz	Plane,Vugh-strongly developed angular blocky	Porphyric, Monic	Crystallitic	Gypsum crystals-Carbonate crystals
BC	Plane,vugh- weakly developed angular blocky,massive	Porphyric	Mosaic-Speckled	-
Profile2(Pea land use)				
Ap	Vugh- granular	Enaulic	Stipple-Speckled	Carbonate nodules-Gypsum crystals
Bkyz1	Vugh-moderately developed subangular blocky	Porphyric	Crystallitic	Fe/Mn nodules
Bkyz2	Plane-developed subangular blocky	Porphyric	Crystallitic	Fe/Mn nodules
Bkyz3	Plane, vugh- moderately developed angular blocky	Porphyric	Crystallitic	-
BC	Plane - moderately developed angular blocky, massive	Porphyric	Crystallitic	-
Profile3(Barley land use)				
Apz	Vugh- granular	Enaulic, Porphyric	Stipple-Speckled	-
Bkyz1	Plane, vugh- moderately developed angular blocky	Porphyric	Crystallitic, Stipple-Speckled	Gypsum crystals-Carbonate coatings
Bkyz2	Vugh- moderately developed angular blocky	Porphyric	Speckled, Crystallitic	Carbonate coating-Carbonate crystals
Bkz1	Channel, chamber-moderately developed subangular blocky	Porphyric	Speckled, Crystallitic	-
Bkz2	Plane-weakly developed subangular blocky	Porphyric	Speckled	-
Profile4(Non-cultivated)				
Ap	Compound Packing-weakly developed angular blocky, granular	Porphyric	Stipple-Speckled	-
Btkz1	Plane-moderately developed angular blocky	Porphyric	Mosaic-Speckled	Clay coating, Quartz infilling
Btkz2	Plane, vugh,channel-angular blocky	Porphyric	Crystallitic, Speckled	Clay coating, Gypsum crystals
Bkz	Plane,vugh- angular blocky	Porphyric	Crystallitic, Speckled	-
Bk	Plane, vugh- weakly developed angular blocky	Porphyric	Mosaic-Speckled	-

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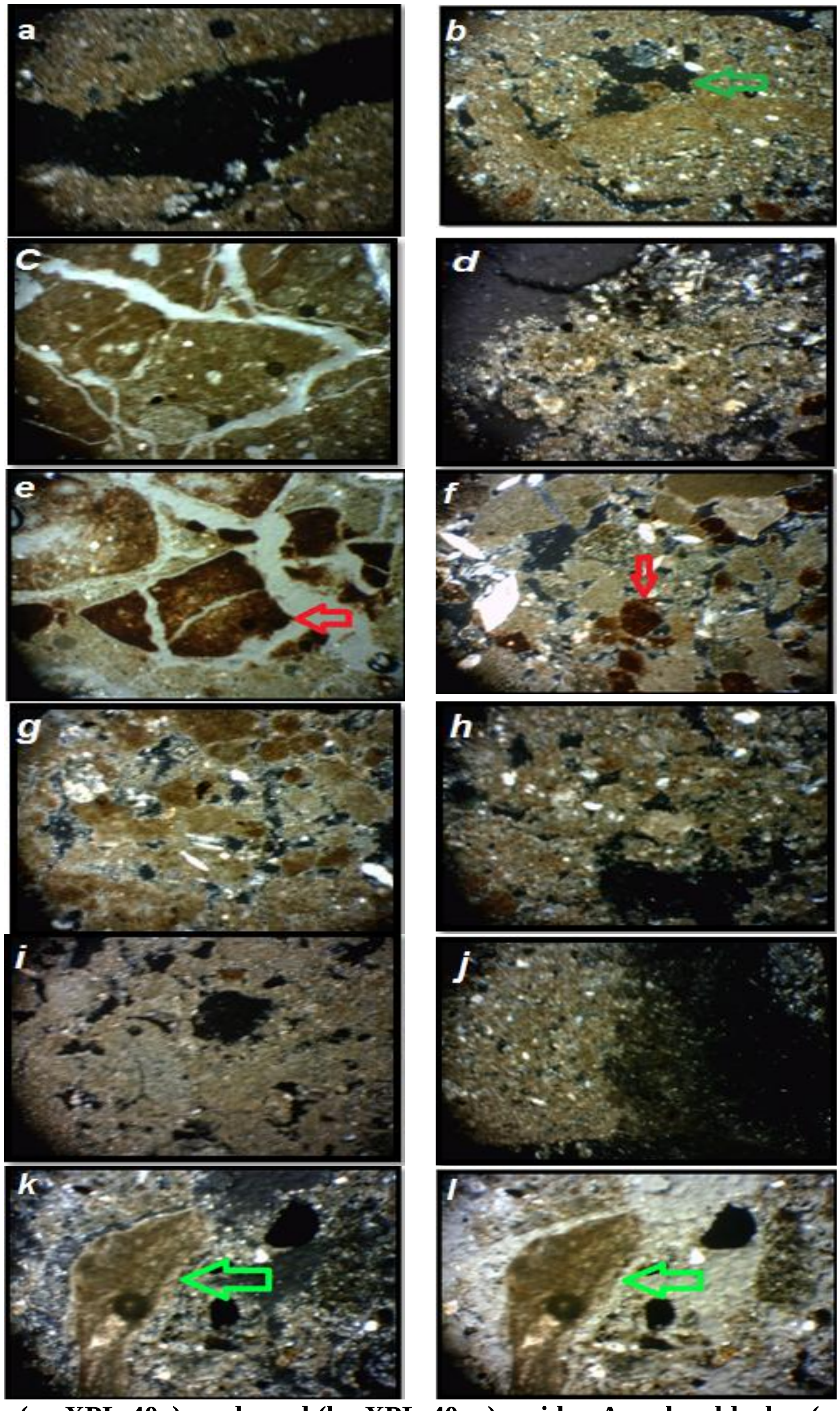

Figure 1: Plane(a, XPL-40x) and vugh(b, XPL-40x) voids; Angular blocky (c, PPL-40x and granular(d, XPL-40x) microstructure; Fe nodule (e, PPL-40x) and Fe/Mn nodules(f, XPL-40x) ;Crystallitic(g, XPL-40x), stipple-speckled(h, XPL-40x) and mosaic-speckled(i, XPL-40x) b-fabric; Clay coating (j,XPL40x); calcium carbonate nodule (k, XPL-40x) and calcium carbonate nodule (l, PPL-40x).

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