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Classification of the soils formed in toposequence Kayi and Aydinpinar streams (Tekirdag) and classes of suitability to agricultural uses

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Abstract. The soils formed in the vicinity of Kayı and Aydınpınar streams were investigated in transects formed toposequence splitting vertically towards the coastal line of Thrace region. On the characteristic points of topography formed by the Kayı and Aydınpınar streams, five soil profiles were described, the two on the Oligocene marine deposits, the two on side stream creeks and the one on the alluvial bed representing low land. The morphological, physical and chemical properties of the samples taken from these profiles according to the genetic horizon principle were determined. The classification of these soils formed in the toposequence relationship and their suitability to various plants varieties were determined. The 4th profile in subgroup of Typic Xerofluvent were formed in alluvial land, The 2nd profile in subgroup of Calcic Haploxerept, 1st, 3rd and 5th profiles in subgroup of Typic Haploxerept were classified.
The soil formed in a toposequence is different for suitability of plant cultivation varies. KA1, KA2 and KA5 soils are highly suitable for grass families expect maize and sudan grass while KA3 soil is medium suitable for grass families. KA1 and KA2 soils (expect soybean) are highly suitable, KA3 (expect alfalfa and sainfoin) and KA5 (expect alfalfa) soils are medium suitable and KA4 soil is marginal suitable for legume plants.

Key words: Soil genesis, toposequence, entisols, inceptisols.

INTRODUCTION

One of the prerequisites for the management and planning of agriculture is the use of agricultural lands in accordance with the nature and ability of the land with the sustainable land management theories that must be applied. In this, the definition of the characteristics of the soil, the conditions of soil formation and soil genesis events and the position in the nature should be examined well.

Sharma et al. (1994) studied the physicochemical properties of soil formation on a toposequence in the Indore Region of Malwa Plateau. In the study, the profiles of four soil series named Dakachya, Saral, Baloda and Malikhedi were examined and the effects on morphological characteristics were observed. According to the texture analysis, no definite change was detected by the reduction of the slope or depth. The rate of $CaCO_3$ content increased with decreasing inclination of all profiles. The proportion of organic content was low on the surface, and it decreased with depth.

Integrated Toposequence Analysis (ITA) was used to integrate scientific and local knowledge on land resources and land use systems and to identify factors determining land use and land resource management (Gobin et al., 2000). The application of ITA at different toposequence types resulted in a nested, geo-referenced information system relevant to different decision-making levels, and demonstrated the variation in soils, land cover use and cropping systems between landform complexes macro, unit landforms meso and facets micro at the Nsukka Agricultural Zone southeastern Nigeria by Gobin et al. (2000). The local soil classification was coupled to the World Reference Base for Soil Resources using the results of three toposequences and eight soil profile pits. Despite the overall low soil fertility, distinct differences in cropping systems and cultivation techniques were practiced. Local land use and management decisions were guided by the local soil classification and depended on the position in the landscape, the soil texture, occurrence of ironstone and soil color to tillage depth. The local knowledge provided insights in present management strategies, whereas the scientific information demonstrated the constraints on present land use systems.

In a large stream network system in Thrace Region, a partially flattened peneplain (flattened plain) formed the most important macro-topographic structure. This plain joins the Marmara Sea with its final boundary in the Tekirdag Region, and thus in the study area, with the Oligocene marine sediments forming sea forms. In the meantime, it ensured that the tectonic events take place in a fluctuating position. Kayı and Aydınpınar cores formed their own beds and formed low land with alluvial sedimentary environment in the lower and inclined regions of the wavy land.Different soils are formed as a result of topography in soil formation. The purpose of this study is to identify plants that can be grown in these different soils under the same climatic conditions.

MATERIALS AND METHODS

The toposequence that was formed by Kayi and Aydınpinar in the central district of Tekirdag province was examined. On the toposequence formed by the Kayi and Aydınpinar ridges, five soil profiles were described, two on the Oligocene marine sediments, two on the two side stream mouths and one on the alluvial bed representing low land (Boyraz 2003). Alluvial deposits in the Quaternary split the slopes of the marine forms, especially with the new alluvium sediments in Holocene, the material of KA2 and KA3 in the Aydınpinar side and the material of KA4 in the Kayi side and the tin and the clayey textured material in the side of Kayi. The KA1 and KA5 profiles representing high land were opened around the Oligocene marine formations. The KA1 profile, which is surveyed 130 m high from the sea, represents the highest level of profile. The KA5 profile was examined at a height of 80 m above sea level and at low peneplain level of the sea. The cross-section of the physiographic units with the topographic location of the orientation is clearly visible in Fig. 1.

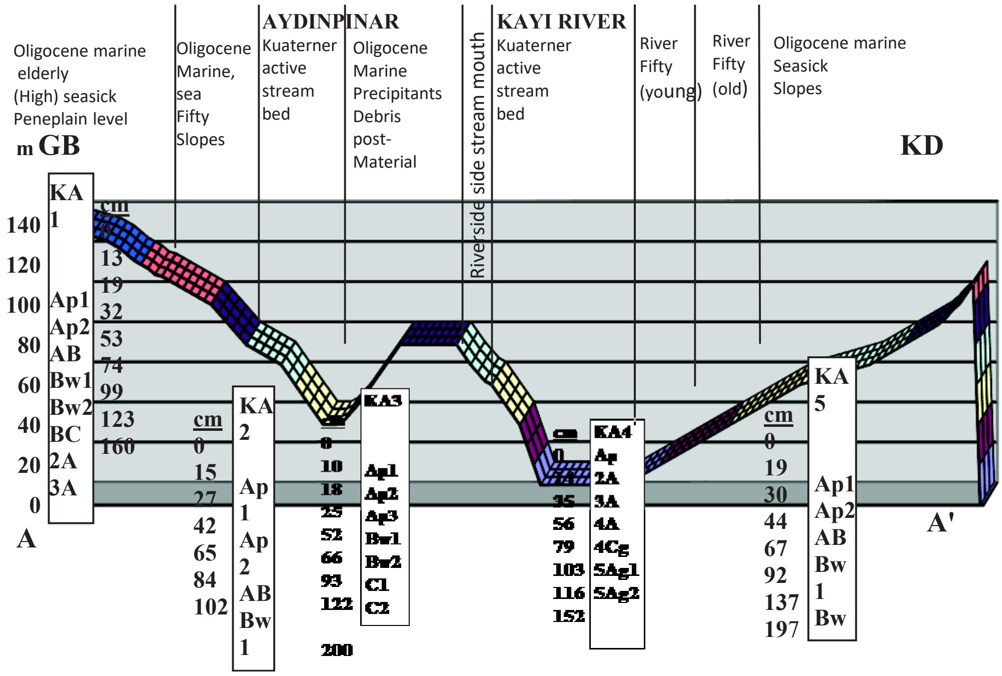


Figure 1. Physiographic location of the study area, Toposequence Dimensional Representation (A-A').

The morphological, physical and chemical properties of the samples taken from these profiles according to the genetic horizon principle were determined. The grain size distribution (texture) was determined according to Soil Survey Staff (1963). Texture triangles are used in the classification of soil textures (Soil Survey Divison Staff, 1993). Content of carbonates was determined by volumetric calcimeter method (Saglam, 2001). The soil reaction (pH) was determined with a glass electrode pH meter in soil suspensions diluted 1/2.5 with water (Jackson, 1958). Bulk density was determined by paraffin method (Schlichting & Blume, 1966). Solid density was found in the degraded soil samples by picnometer method (Black, 1965). Total porosity is calculated according to the method given in Cangir (1991). Hydraulic conductivity is determined according to the method given in Tüzüner (1990). Organic matter quantities were calculated by multiplying the % carbon value obtained by the Smith Weldon method by 1.724 (Saglam, 2001). Total salt ratios were determined by measuring with Wheatstone Bridge conductivity instrument in soil suspensions (Richards, 1954). The cation exchange capacity (CEC) was extracted with ammonium acetate and the Na^+ content was determined by flame photometry (Sağlam, 2001). Conformity classes of soils to various plants were determined according to Mc Rae et al. (1981), Cangir (1988), Sys et al. (1991a), Sys et al. (1991b), Sys et al. (1993). Soils were classified acoording to Soil Survey Staff (2014).

RESULTS AND DISCUSSION

The slope of the soil studied in the toposequence relationship, altitude above sea level, physiography, the surrounding land shape in the and the main material properties are explained in Table 1. The state of the physiographic position of the land and the approximate location of the profile are illustrated in Fig. 1. Some physical and chemical properties of the soil formed on the topography and the parent material that underlie the influence of the drainage network system under the same climatic conditions in a region are given in Table 2–11. The photographs of profiles are given in Figs 2, 3 & 4.

Table 1. Location of physiographic units of research profiles, shape and main material of surroundings

Profile	Slope (%)	Altitude (m)	Coordinate	Physiography	The shape of the surrounding land	Main material
KA1	2–6	130	27º32’23’’Latitude 40º59’32’’ Longitude	High seasickness	Slightly wavy and wavy	Oligocene marine (marine) calcareous, clay- loam textured sediments.
KA2	2–6	30	27º33’11’’ Latitude 40º59’55’’ Longitude	Quaternary active stream bed side stream mouth	Sloping slope land	Limestone sediments; II. Lithologically interrupted low-limest sandy-tin textured fractals; III. Lithologically intermittent calcareous, diagenesis, locally scattered marno limestone.
KA3	2–6	50	27º33’34’’ Latitude 41º00’14’’ Longitude	Side stream mouth of river stream	Floating land	Pelitic (silt + clay) cemented, non-limestone sandstone
KA4	0–2	10	27º33’48’’ Latitude 41º00’35’’ Longitude	Forms of active stream bed of Kayı stream	Straight-near flat	Alluvial deposits with low calcareous texture, usually clay-loam texture
KA5	2–6	80	27º34’42’’ Latitude 41º00’51’’ Longitude	Seaside slopes	Slightly wavy and wavy	Non-calcined Oligocene marine (marine) sediments in the loam texture

Profile description:

Ap1 0–13 cm. Brown (10 YR 4/4, wet), dull yellowish brown (10 YR 5/4, dry); clay loam; strong, coarse and medium, subangular block structure; very hard, very firm, very sticky and very plastic; few, medium thick and very thin roots; no foaming with dilute HCl solution; precise and slightly wavy boundary.

Ap2 13–19 cm. Brown (10 YR 4/4, wet), dull yellowish brown (10 YR 5/3, dry); clay loam; strong, coarse, subangular block structure; very hard, very firm, very sticky and very plastic; little, medium thick and very thin roots; no foaming with dilute HCl solution; precise and slightly wavy boundary.

AB 19–32 cm. Between dull yellowish brown and brown (10 YR 4/3.5, wet), dull yellowish brown (10 YR 5/4, dry); clay loam; strong, coarse and medium, subangular block structure; extremely hard, very firm, very sticky and very plastic; very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

Table 2. Physical analysis results of profile KA1

Horizon	Depth cm	Bulk density g cm^{-3}	Solid density g cm^{-3}	Total porosity %	Hydraulic conductivity cm h^{-1}	Sand %	Silt %	Clay %	Texture classes
Ap1	0–13	1.75	2.69	34.94	0.5	36.55	31.10	32.35	CL
Ap2	13–19	1.58	2.69	41.26	1.2	38.23	27.00	34.77	CL
AB	19–32	1.61	2.64	39.02	0.6	39.03	30.23	30.74	CL
Bw1	32–53	1.61	2.64	39.02	3.2	40.09	25.84	34.07	CL
Bw2	53–74	1.53	2.68	42.91	2.5	40.42	26.96	32.62	CL
BC	74–99	1.63	2.65	38.49	1.2	42.44	27.00	30.56	CL
2A	99–123	1.62	2.67	39.33	5.7	33.45	34.65	31.90	CL
3A	123–160	1.59	2.66	40.23	0.7	41.34	29.12	29.54	CL

Table 3. Chemical analysis results of profile KA1

Horizon	Depth cm	pH 1/2.5 soil-water	Salt %	Organic matter %	CEC cmol kg^{-1}	$CaCO_3$ %
Ap1	0–13	7.12	0.018	2.17	28.48	0.0
Ap2	13–19	6.97	0.019	1.79	27.34	0.0
AB	19–32	7.28	0.031	1.30	29.08	0.0
Bw1	32–53	7.13	0.021	1.23	27.37	0.0
Bw2	53–74	7.64	0.028	0.94	28.99	0.0
BC	74–99	7.39	0.029	0.34	28.51	0.0
2A	99–123	7.53	0.029	1.48	29.70	0.0
3A	123–160	7.50	0.019	1.75	29.56	0.0

Bw1 32–53 cm. Dull yellowish brown (10 YR 4/3, wet), dull yellowish brown (10 YR 5/3, dry); clay loam; strong, very coarse and coarse, angular block structure; extremely hard, extremely firm, very sticky and very plastic; very, very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

Bw2 53–74 cm. Dull yellowish brown (10 YR 4/3, wet), dull yellowish brown (10 YR 5/4, dry); clay loam; strong, very coarse, angular block structure; extremely hard, extremely firm, very sticky and very plastic; plenty, very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

BC 74–99 cm. Dull yellowish brown (10 YR 4/3, wet), dull yellowish brown (10 YR 5/4, dry); clay loam; medium- strong, very coarse and coarse, angular block structure; very hard, very firm, very sticky and very plastic; few, thin and plenty, very thin roots; no foaming with dilute HCl solution; precise and wavy boundary.

2A 99–123 cm. Between dull yellowish brown and brown (10 YR 4/3.5, wet), dull yellowish brown (10 YR 5/4, dry); clay loam; medium – weak, fine, subangular block structure; hard, firm, very sticky and very plastic; very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

3A 123–160 cm. Dull yellowish brown (10 YR 4/3, wet; 10 YR 5/3, dry); clay loam; weak, medium, subangular block structure; hard, loose, very sticky and very plastic; very, very thin roots; no foaming with dilute HCl solution.

Table 4. Physical analysis results of profile KA2

Horizon	Depth cm	Bulk density g cm^{-3}	Solid density g cm^{-3}	Total porosity %	Hydraulic conductivity cm h^{-1}	Sand %	Silt %	Clay %	Texture classes
Ap1	0–15	1.58	2.69	41.26	3.4	34.54	38.25	27.21	CL–L
Ap2	15–27	1.45	2.71	46.49	4.2	43.02	25.48	31.50	CL
AB	27–42	1.65	2.68	38.43	4.0	40.47	25.68	33.85	CL
Bw1	42–65	1.60	2.66	39.85	1.8	40.45	33.74	25.81	L
Bw2	65–84	1.63	2.70	39.63	2.6	41.43	32.73	25.84	L
BC	84–102	1.58	2.66	40.60	2.0	42.85	33.57	23.58	L
C	102–138	1.70	2.62	35.11	3.4	42.64	31.59	25.77	L
2Cr	138–186	1.98	2.67	25.84	5.8	71.26	21.71	7.03	SL
3C	186–270	1.92	2.71	29.15	0.8	52.01	41.30	6.69	SL
3R	270+	-	-	-	-	-	-	-	-

Table 5. Chemical analysis results of profile KA2

Horizon	Depth cm	pH 1/2.5 soil-water	Salt %	OrganicMatter %	CEC cmol kg^{-1}	$CaCO_3$ %
Ap1	0–15	7.72	0.027	1.51	29.55	10.09
Ap2	15–27	7.68	0.024	1.84	29.98	9.52
AB	27–42	7.73	0.022	1.38	30.85	9.33
Bw1	42–65	7.38	0.021	0.99	28.98	9.24
Bw2	65–84	7.50	0.024	0.92	29.55	9.62
BC	84–102	7.53	0.024	0.77	28.65	10.20
C	102–138	7.56	0.027	0.52	29.55	9.45
2Cr	138–186	7.70	0.020	0.34	10.47	4.43
3C	186–270	7.80	0.018	0.17	9.81	19.63
3R	270+	-	-	-	-	58.08

Profile description:

Ap1 0–15 cm. Yellowish grey (2.5 Y 5/4, wet), dull yellow (2.5 Y 6/4, dry); between clay loam and loam; moderate, coarse, granular and weak, fine, subangular block structure; hard, firm, very sticky and very plastic; medium plenty, thin and very thin roots; medium foaming with dilute HCl solution; precise and wavy boundary.

Ap1 15–27 cm. Yellowish grey (2.5 Y 5/4, wet), dull yellow (2.5 Y 6/4, dry); clay loam; moderate, fine, subangular block structure; very hard, firm, very sticky and very plastic; medium plenty, thin and very thin roots; medium foaming with dilute HCl solution; precise and wavy boundary.

AB 27–42 cm. Yellowish grey (2.5 Y 5/4, wet), dull yellow (2.5 Y 6/4, dry); clay loam; weak- moderate, fine, subangular block structure; slightly hard, loose, very sticky and very plastic; few, thin and very thin roots; medium foaming with dilute HCl solution; precise and wavy boundary.

Bw1 42–65 cm. Olive brown (2.5 Y 4/4, wet), dull yellow (2.5 Y 6/4, dry); loam; strong –moderate, coarse, subangular block structure; hard, firm, very sticky and very plastic; few, thin and very thin roots; medium foaming with dilute HCl solution; smooth and gradual boundary.

Bw2 65–84 cm. Yellowish grey (2.5 Y 5/4, wet), dull yellow (2.5 Y 6/2, dry); loam; strong –moderate, coarse, subangular block structure; hard, firm, very sticky and very plastic; medium plenty, thin roots; medium foaming with dilute HCl solution; precise and wavy boundary.

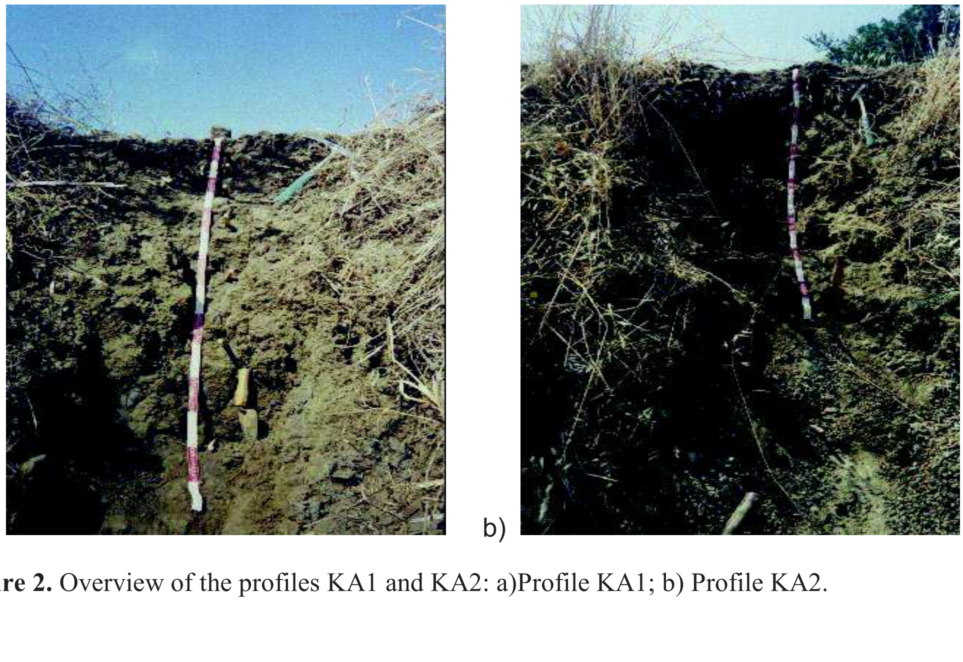
BC 84–102 cm. Yellowish grey (2.5 Y 5/4, wet), dull yellow (2.5 Y 6/4, dry); loam; moderate, coarse- very coarse, subangular block structure; hard, firm, very sticky and very plastic; medium plenty, thin roots; medium foaming with dilute HCl solution; precise and wavy boundary.

C 102–138 cm. Light yellow (2.5 Y 7/4, wet), yellowish grey (2.5 Y 5/4, dry); loam; massive- moderate, medium- coarse, angular block structure; hard, firm, very sticky and very plastic; few, thin roots; medium foaming with dilute HCl solution; precise and wavy boundary.

2Cr 138–186 cm. Yellowish grey (2.5 Y 5/4, wet), dull yellow (2.5 Y 6/3.5, dry); sandy loam; massive- when they are broken up, they are scattered in the form of square and rectangle prisms of 1–1.5 cm; hard, firm, very sticky and very plastic; medium plenty, thin roots; clear foaming with dilute HCl solution; gradual and wavy boundary.

3C 186–270 cm. Light yellow (5 Y 7/3, wet), olive yellow (5 Y 6/4, dry); sandy loam; massive; soft, very friable, very sticky and very plastic; severe and persistent foaming with dilute HCl solution; gradual and wavy boundary.

3R 270+ cm. Severe and persistent foaming with dilute HCl solution diagenesis site diffracted marno limestone.



a) b)

Figure 2. Overview of the profiles KA1 and KA2: a)Profile KA1; b) Profile KA2.

Table 6. Physical analysis results of profile KA3

Horizon	Depth cm	Bulk density g cm^{-3}	Solid density g cm^{-3}	Total porosity %	Hydraulic conductivity cm h^{-1}	Sand %	Silt %	Clay %	Texture classes
Ap1	0–10	1.64	2.60	36.92	8.8	32.80	27.30	39.90	CL-C
2Ap2	10–18	1.78	2.62	32.06	5.1	60.75	14.57	24.68	SCL
2Ap3	18–25	1.75	2.62	33.21	7.0	60.48	15.71	23.81	SCL
2Bw1	25–52	1.74	2.73	36.26	9.9	61.02	17.35	21.63	SCL
2Bw2	52–66	1.74	2.64	34.09	9.1	64.98	14.32	20.70	SCL
2C1	66–93	1.69	2.73	38.10	3.2	63.33	15.55	21.12	SCL
2C2	93–122	1.69	2.69	37.17	13.2	70.65	12.41	16.94	SL
2Cr	122–200	1.71	2.67	35.96	6.0	73.69	10.37	15.94	SL

Table 7. Chemical analysis results of profile KA3

Horizon	Depth cm	pH 1/2.5 soil-water	Salt %	OrganicMatter %	CEC cmol kg^{-1}	$CaCO_3$ %
Ap1	0–10	7.44	0.016	1.84	27.72	0.0
2Ap2	10–18	7.25	0.011	1.65	25.73	0.0
2Ap3	18–25	7.32	0.016	1.50	21.29	0.0
2Bw1	25–52	7.77	0.029	1.45	21.73	0.0
2Bw2	52–66	7.74	0.026	1.06	20.48	0.0
2C1	66–93	7.68	0.026	0.55	21.96	0.0
2C2	93–122	7.59	0.020	0.45	17.47	0.0
2Cr	122–200	7.58	0.021	0.29	17.91	0.0

Profile description:

Ap1 0–10 cm. Dull yellowish brown (10 YR 5/3, wet), dull yellowish orange (10 YR 6/3, dry); clay loam; moderate, fine, subangular block structure; hard, firm, very sticky and very plastic; very, thin and very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

2Ap2 10–18 cm. Brown (10 YR 6/4, wet), between dull yellowish orange and light yellowish brown (10 YR 6/5, dry); sandy clay loam; weak, fine, subangular block structure; slightly hard, loose, sticky and plastic; very, thin and very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

2Ap3 18–25 cm. Brown (10 YR 4/5, wet), yellowish brown (10 YR 5/6, dry); sandy clay loam; moderate, medium, subangular block structure; hard, firm, very sticky and very plastic; very, thin and very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

2Bw1 25–52 cm. Brown (10 YR 4/5, wet), dull yellowish brown (10 YR 5/4, dry); sandy clay loam; moderate, medium, angular block structure; hard, firm, very sticky and very plastic; very, thin and very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

2Bw2 52–66 cm. Brown (10 YR 4/5, wet), between dull yellowish brown and brown (10 YR 5/5, dry); sandy clay loam; moderate, fine, subangular block structure; slightly hard, loose, very sticky and very plastic; very, thin and very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

2C1 66–93 cm. Brown (10 YR 4/4, wet), dull yellowish brown (10 YR 5/4, dry); sandy clay loam; massive-weak, fine, subangular block structure; slightly hard, firm, very sticky and very plastic; few, thin and very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

2C2 93–122 cm. Brown (10 YR 4/6, wet), yellowish brown (10 YR 5/6, dry); sandy loam; massive; hard, loose, sticky and plastic; few, very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

2Cr 122–200 cm. Brown (10 YR 4/6, wet), dull yellowish orange (10 YR 6/4, dry); sandy loam; partially consolidated parent material; hard, loose, sticky and plastic; few, very thin roots; no foaming with dilute HCl solution.

Table 8. Physical analysis results of profile KA4

Horizon	Depth cm	Bulk density g cm^{-3}	Solid density g cm^{-3}	Total porosity %	Hydraulic conductivity cm h^{-1}	Sand %	Silt %	Clay %	Texture classes
Ap	0–14	1.75	2.63	33.46	2.1	13.97	46.22	39.81	SiCL
2A	14–35	1.69	2.76	38.77	0.3	28.14	41.24	30.62	CL
3A	35–56	1.79	2.70	33.70	2.7	30.03	43.13	26.84	L
4A	56–79	1.78	2.69	33.83	1.5	24.41	43.29	32.30	CL
4Cg	79–103	1.73	2.69	35.69	0.7	25.96	44.46	29.58	CL
5Ag1	103–116	1.80	2.71	33.60	0.02	27.30	39.56	33.14	CL
5Ag2	116–152	1.80	2.64	31.82	0.5	26.99	42.52	30.49	CL

Table 9. Chemical analysis results of profile KA4

Horizon	Depth cm	pH 1/2.5 soil-water	Salt %	OrganicMatter %	CEC cmol kg^{-1}	$CaCO_3$ %
Ap	0–14	8.15	0.086	2.56	37.32	4.22
2A	14–35	8.11	0.049	3.15	34.61	4.22
3A	35–56	7.95	0.074	4.07	28.39	4.40
4A	56–79	8.15	0.057	3.61	30.58	4.58
4Cg	79–103	7.75	0.062	1.07	21.57	4.97
5Ag1	103–116	7.71	0.060	2.46	22.92	4.97
5Ag2	116–152	7.86	0.066	1.28	23.27	4.39

Profile description:

Ap 0–14 cm. Greyish olive (5 Y 4/2, wet; 5 Y 6/2, dry); silt clay loam; strongly-moderate, medium-fine, subangular block structure and strongly medium-fine granular structure; extremely hard, extremely firm, very sticky and very plastic; very medium and very, thin and very thin roots; clear foaming with dilute HCl solution; clear and wavy boundary.

2A 14–35 cm. Greyish olive (5 Y 4/2, wet; 5 Y 5/2, dry); clay loam; strongly, course, subangular block structure and strongly medium-fine granular structure; extremely hard, extremely firm, very sticky and very plastic; very medium and very, thin and very thin roots; clear foaming with dilute HCl solution; clear and wavy boundary.

3A 35–56 cm. Between dark greyish yellow and olive brown (2.5 Y 4/2.5, wet), dull yellow (2.5 Y 6/3, dry); loam; moderate, fine, granular and moderate, medium, subangular block structure; extremely hard, extremely firm, very sticky and very plastic; plenty, medium and very, thin and very thin roots; clear foaming with dilute HCl solution; gradual and wavy boundary.

4A 56–79 cm. Olive brown (2.5 Y 4/3, wet), Between dark greyish yellow and yellowish gray (2.5 Y 5/2.5, dry); clay loam; strongly medium, angular block structure; extremely hard, extremely firm, very sticky and very plastic; plenty, medium and very, thin and very thin roots; clear foaming with dilute HCl solution; gradual and wavy boundary.

4Cg 79–103 cm. Yellowish gray (2.5 Y 5/3, wet), dull yellow (2.5 Y 6/3, dry); clay loam; massive; extremely hard, extremely firm, very sticky and very plastic; plenty, medium and very, thin and very thin roots; widespread, medium to large, striking, lateral stripes and banded, sharp yellowish reddish color vests; clear foaming with dilute HCl solution; clear and smooth boundary.

5Ag1 103–116 cm. Grayish olive (5 Y 4/2, wet; 5 Y 5/2, dry); clay loam; massive-strongly, medium- course, prismatic structure; extremely hard, extremely firm, very sticky and very plastic; few, medium and very, thin and very thin roots; small, medium and large, round, like color spots, common, small and medium large, striking, banded, sharp reddish yellow color vests; clear foaming with dilute HCl solution; gradula and wavy boundary.

5Ag2 116–152 cm. Grayish olive (5 Y 5/3, wet), between grayish olive and olive yellow (5 Y 6/2.5, dry); clay loam; massive- moderate, medium- course, prismatic structure; extremely hard, extremely firm, very sticky and very plastic; very, thin and very thin roots; broad, medium and large, striking, banded and round, sharp reddish yellow vignettes; clear foaming with dilute HCl solution.

a) 

b) 

Figure 3. Overview of the profiles KA3 and KA4: a Profile KA3; b) Profile KA4.

Table 10. Physical analysis results of profile KA5

Horizon	Depth cm	Bulk density g cm^{-3}	Solid density g cm^{-3}	Total porosity %	Hydraulic conductivity cm h^{-1}	Sand %	Silt %	Clay %	Texture classes
Ap1	0–19	1.66	2.70	38.52	1.7	32.02	41.64	26.34	L
Ap2	19–30	1.60	2.68	40.29	0.7	42.12	36.62	21.26	L
AB	30–44	1.65	2.69	38.66	1.8	38.01	37.63	24.36	L
Bw1	44–67	1.71	2.69	36.43	1.0	36.79	38.78	24.43	L
Bw2	67–92	1.71	2.68	36.19	1.2	35.88	38.70	25.42	L
BC	92–137	1.69	2.61	35.25	1.0	36.76	38.80	24.44	L
CB	137–197	1.66	2.76	39.86	6.6	35.61	39.91	24.48	L
C	197+	1.82	2.76	34.06	8.6	33.07	40.18	26.75	L

Table 11. Chemical analysis results of profile KA5

Horizon	Depth cm	pH 1/2.5 soil-water	Salt %	Organic Matter %	CEC cmol kg^{-1}	$CaCO_3$ %
Ap1	0–19	7.67	0.027	2.10	25.85	0.0
Ap2	19–30	7.78	0.038	2.89	26.14	0.0
AB	30–44	7.75	0.026	2.04	24.19	0.0
Bw1	44–67	7.91	0.048	1.45	22.88	0.0
Bw2	67–92	7.75	0.025	0.84	22.84	0.0
BC	92–137	7.79	0.046	0.66	21.68	0.0
CB	137–197	7.91	0.040	0.69	25.24	0.0
C	197+	7.85	0.029	0.34	26.08	0.0

Profile description:

Ap1 0–19 cm. Dull yellowish brown (10 YR 4/3, wet; 10 YR 5/4, dry); loam; weak, fine, subangular block structure; hard, loose, very sticky and very plastic; few medium and very, thin and very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

Ap2 19–30 cm. Between dull yellowish brown and greyish yellow brown (10 YR 4/2.5, wet), dull yellowish brown (10 YR 5/3, dry); loam; weak, medium-fine, subangular block structure; hard, loose, very sticky and very plastic; few medium and very, thin and very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

AB 30–44 cm. Dull yellowish brown (10 YR 4/3, wet; 10 YR 5/2.5, dry); loam; strongly, medium- course, angular block structure; hard, firm, very sticky and very plastic; very, thin and very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

Bw1 44–67 cm. Between dull yellowish brown and brown (10 YR 4/3.5, wet), dull yellowish brown (10 YR 5/4, dry); loam; strongly, course, subangular block structure; very hard, firm, very sticky and very plastic; very, thin and very thin roots; no foaming with dilute HCl solution; clear and wavy boundary.

Bw2 67–92 cm. Dull yellowish brown (10 YR 4/3, wet; 10 YR 5/4, dry); loam; strongly, course, subangular block structure; very hard, very firm, very sticky and very plastic; very, thin and very thin roots; no foaming with dilute HCl solution; gradual and wavy boundary.

BC 92–137 cm. Dull yellowish brown (10 YR 4/3, wet), dull yellowish orange (10 YR 6/4, dry); loam; strongly-moderate, very course, angular block structure; very hard, very firm, very sticky and very plastic; few, thin and very thin roots; no foaming with dilute HCl solution; gradual and wavy boundary.

CB 137–197 cm. Between dull yellowish brown and dark brown (10 YR 3.5/3, wet), dull yellowish orange (10 YR 6/4, dry); loam; moderate- strongly, course, angular block structure; very hard, firm, very sticky and very plastic; few, thin and very thin roots; no foaming with dilute HCl solution; gradual and wavy boundary.

C 197+ cm. Dull yellowish brown (10 YR 4/3, wet), dull yellowish brown (10 YR 5/4, dry); loam; moderate, medium, subangular block structure; hard, firm, very sticky and very plastic; no foaming with dilute HCl solution.

Figure 4. Overview of the profile KA5.

The classification of the soils that differ in a toposequence relationship is presented in Table 12. It has been determined that the soils formed on a toposequence differ in Order and suboundary levels. Land suitability orders show whether land is suitable for different purposes. Land that is not dangerous to damage the land resources and meets the rentable farming conditions of the arrivals by covering the cost is included in the appropriate ‘S’. It is numbered according to the degree of eligibility. It is numbered according to the degree of eligibility. On the other hand, land without economic value in special agricultural practices, which will be harmful at the end of a certain period of time when it is used immediately or continuously, is considered in ‘N’ order which is not suitable.

Table 12. Classification of soil profiles according to of soil taxonomy (Soil Survey Staff, 2014)

Soil Taxonomy (2014)				Profiles
Orders	Suborders	Great groups	Subgroups	
Entisol	Fluvent	Xerofluvent	Typic Xerofluvent	KA4
Inceptisol	Xerept	Haploxerept	Calcic Haploxerept	KA2
			Typic Haploxerept	KA1, KA3, KA5

The 29 cultivated plants, which may be adapted to the ecological conditions of the lands of a toposequence, are given in Table 13 with the conformity classes under 7 families.

Table 13. Suitability classes of agricultural uses of research profiles

Land usage types	Profiles				
	KA1	KA2	KA3	KA4	KA5
A) Grass (*Poaceae*)					
Wheat	S1*	S1*	S2	S2	S1*
Barley	S1**	S1**[a]	S2	S2	S1
Rye	S1*	S1*	S2	S2	S1*
Maize	S2***	S1***	S2***	S3	S1***
Sudan grass	S1*	S1*	S3	S3	S2
B) Legume plants (*Fabaceae*)					
Soybeans	S1*	S2*	S2	S3	S2
Bean	S1*	S1*	S2	S3	S2
Peas	S1*	S1*	S2	S3	S2
Chickpea – lentil	S1*	S1*	S2	S3	S2
Alfalfa	S1*	S1*	S3	S3	S1*
Hungarian vetch	S1*	S1*	S2	S3	S2
Sainfoin	S1*	S1*	S1*	S3	S2
C) Onions (*Alliaceae*)					
Carrot	S2*	S2*	S2	S3	S3
Onion-garlic- leek	S1*	S2*	S1*	S3	S1*
D) Solanaceous plants (*Solanaceae*)					
Potato	S2*	S2*	S2	S3	S2
Pepper-eggplant	S2***	S2***	S2***	S3	S2***
Tomato	S1*	S2*	S3	S3	S2
E) Cucurbits (*Cucurbitaceae*)					
Watermelon-melon	S1*	S2*	S3	S3	S2
Zucchini- cucumber	S2*	S2*	S2	S3	S2
F) Brassiras (*Brassicaceae*)					
Cabbage	S1*	S1*	S1*	S3	S1
Canola	S1*	S1*	S2	S3	S2
G) Astereaous (*Astereceae*)					
Sunflower	S1*	S1*	S3	S3	S2
H) Pasture area					
Pasture	S1	S1	S1	S2	S1
I) Forestry and recreation areas					
Deciduous forest	S1	S1	S1	S2	S1
Coniferous Trees	S2	S2	S2	S3	S3

* 0–4% slope for S1; % 4–8 slope for S2; 8–16% slope for S3; ** % < 6 slope for S1; 6–12% slope for S2; *** 0–2% slope for S1; 2–4% slope for S2; 4–6% slope for S3; % > 6 slope for N2.

S1 – Products that do not have significant limitations against the continued application of a usage class that provides more than 85% of the maximum product efficiency at a high level, or that have insignificant limits that will not significantly reduce productivity or profitability, and will not exceed the acceptable levels of inputs.

S2 – Medium to medium-term limits for the continuous application of a usage class that provides 60–85% of maximum product yield. Disadvantages that provide limitations reduce productivity or profitability and increase the level of input required, while all the benefits of using the land provide the attractiveness of the destination. However, it is considerably lower than the anticipated productivity in class 1 (S1). Both feasible and economical are likely to require matching inputs.

S3 – This is a land that has collectively severe limitations against the continuous application of this use class, which provides 40–60% of the maximum product yield at marginal. This spending only provides marginal profitability, while the disability that limits them reduces productivity and profitability and increases the level of inputs required. It needs inputs that are applied but economical under favorable conditions.

The 2 order that fall into the non-conforming class is summarized below with typical characteristics.

N1 – Temporary unavailable Not suitable for currently used operation which provides 25–40% of maximum product efficiency. In today's conditions, cost-wise productivity has a certain limit. However, it should also be taken into account that over time, the apologies can be made. Limitations are so severe as to prevent successful and continuous use of the land at the desired level.

N2 – Continuous is not suitable and provides < 25% of maximum product efficiency and is never economically feasible given implementation practices. The intended use has severe limitations to the extent that it will prevent the possibility of successful and continuous use in the desired manner against the product.

CONCLUSIONS

The soil formed in a toposequence sequence is different for suitability of plant cultivation varies. KA1, KA2 and KA5 soils are highly suitable for grass families except maize and sudan grass while KA3 soil is medium suitable for grass families. KA1 and KA2 soils (except soybean) are highly suitable, KA3 (except alfalfa and sainfoin) and KA5 (except alfalfa) soils are medium suitable and KA4 soil is marginal suitable for legume plants. KA1 soil is highly suitable for onion-garlic-leek, tomato, watermelon-melon, cabbage, canola, sunflower, pasture, deciduous forest crops and is medium suitable for carrot, potato, pepper- eggplant, zucchini- cucumber, coniferous trees. KA2 soil is highly suitable for cabbage, canola, sunflower, pasture, deciduous forest crops and is medium suitable for onion-garlic-leek, carrot, potato, pepper-eggplant, tomato, zucchini- cucumber, coniferous trees. KA3 soil is highly suitable for onion-garlic-leek, cabbage, pasture, deciduous forest crops, is medium suitable for carrot, potato, pepper-eggplant, zucchini- cucumber, canola, coniferous tree and is marginal suitable for tomato, watermelon-melon, sunflower. KA4 soil is medium suitable for pasture, deciduous forest and is marginal suitable for carrot, onion-garlic-leek, tomato, watermelon-melon, cabbage, canola, sunflower, potato, pepper- eggplant, tomato, watermelon-melon, zucchini- cucumber, cabbage, canola, sunflower, coniferous trees. KA5 soil is highly suitable for onion-garlic-leek, cabbage, pasture, deciduous forest, is medium suitable for potato, pepper-eggplant, tomato, watermelon-melon, zucchini-cucumber, canola, sunflower and marginal suitable for carrot, coniferous trees.

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