CLIMATIC CONDITIONS AND EVOLUTION OF SOIL PROFILES IN ROMANIA

ILIE L., MIHALACHE M., MARIN D.I., SCĂEȚEANU GINA
University of Agronomic Sciences and Veterinary Medicine of Bucharest, Blv. Mărăşti, no. 59, Bucharest, 011464, Romania

Key words: climate, soil profiles, agricultural ecosystem

ABSTRACT

For over a century has been recognized the climate role in genesis and evolution of soil profiles and initial area classification indicated the types of soil after their climate zones.

Climate was characterized by an annual average temperature of the coldest month (January) and the most warm month (July). For expressed the moisture has been used average annual rainfall (mm).

To investigate the influence of climatic conditions on the evolution of soil profiles were selected a group of samples belonging to agricultural, pastoral and forestry ecosystems. For each profile was analyzed the first two horizons where the climate is more intense.

Climate data shows that they determine the intensity of decomposition processes of plants, the accumulation and mineralisation of organic matter.

INTRODUCTION

To investigate the influence of climatic conditions on the evolution of soil profiles were selected a group of samples belonging to agricultural, pastoral and forestry ecosystems. Each profile was analyzed the upper horizons where the climate is more intense.

Climate data shows that they determine the intensity of decomposition processes of plants, the accumulation and mineralisation of organic matter.

Thus, the average annual temperatures, the coldest and warmest month increase, cause increased organic material mineralisation and decreased the organic material, total nitrogen and total phosphorus accumulation, in surface horizons of soils.

On the other hand, increasing annual precipitation and aridity index, increased accumulation of organic material and increased eluviation of release ions and clay-humus colloids.

Nitrogen is mostly bound to organic matter and phosphorus inherited from the parent material is retained by bioaccumulation on the surface horizons.

MATERIAL AND METHODS

Climate was characterized by a mean annual temperature of the coldest month (January) and the warmest month (July) expressed in Celsius degrees (^{0}C). For moisture regime was used average annual rainfall (mm). It has also been used aridity index, by Koppen, expressed as ratio of average precipitation / average annual temperature + 10, which has been used for the past eight decades for delimitation steppe, temperate and boreal climate. At each profile were assessed climate data after the nearest weather station.

Were selected 138 soil profiles of the main soil types in all climate zones of Romania and because the effects of climatic conditions are more intense in the surface layer, were investigated first two horizons A and less OA and AB is only when the first horizon has less than 10 cm thick.

RESULTS AND DISCUSSION

Climatic regions of Romania are determined by its geographic position in Central and South-Eastern Europe, crossed by 45th parallel north latitude, relief and vegetation. Carpathian mountain chain in the country has a boreal climate (DFK), with rainfall throughout the year, cold winter, the average annual temperature below 8 ^{0}C, the temperature of the warmest month below 18 ^{0}C and general aridity indices greater than 45 (Florea N. et al, 1968). Soils in this climate area are dystric cambisols, podzols and humic leptosol. They have short profiles, skeletal character because hard parental rocks.

Natural vegetation placed parallel climatic zones with a succession from alpine meadows to coniferous forests in the boreal province, to deciduous forests in the temperate province to steppe with grasses. This requires research into agricultural, pastoral and forestry ecosystems to estimate the influence of vegetation and agricultural technologies on the development of soil profiles.

Parallelism but not identity between climatic conditions and soil types shows the determining influence of climate in the formation of soil profiles. Indeed, the processes of soil formation (pedogenesis), soil horizons are formed by the accumulation of organic material and nutrients at the soil surface by humification and mineralisation plant residues and ions eluviation to depth, possibly accompanied by translocation of soil colloids.

Average temperatures decline in the following order: agricultural ecosystems, forestry and pastoral and annual rainfall and aridity indices increased in the same sequence.

Distribution of the three ecosystems samples like a organic material - aridity index graphic (Fig. 1) shows that the points corresponding agricultural ecosystems are grouped in a small area at relatively low values of variables while those of natural ecosystems are spread throughout space diagram. Points of pastoral ecosystem occupies a large space especially for big values of aridity index while key points of forestry ecosystems covering an extended area, especially to higher content of organic material. This shows that tree vegetation increase humification and minimizes mineralisation of organic material, in pastoral ecosystems, especially those from alpine to low temperatures and high rainfall, increase more mineralisation.

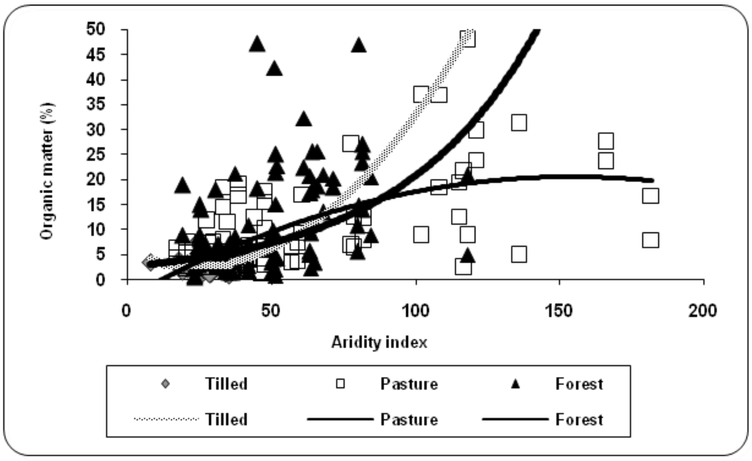

Fig. 1 Relationship between organic matter content and aridity index

However, areas of natural ecosystems overlapping points of each other and emphasize the balance between humification and mineralisation of organic material is strongly influenced by relief, microclimate and vegetation. On the other hand, agricultural ecosystems because contain chernozems and luvisols with a uniform A horizons by mixing A with E or AB, on arid or temperate climates, have a small area.

Total nitrogen is very closely linked to organic material (n=276, R_{pow}=0.933***, R_{lin}=0.907***, F=1271) and suggests that it is a constituent of his. Nitrogen increases with the organic material content (Fig. 2) in all ecosystems: agricultural (n=102, R_{pow}=0.910***, R_{lin}=0.906***, F=38.4), pastoral (n=82, R_{poly}=0.937***, R_{lin}=0.891***, F=309) and forestry (n=92, R_{pow}=0.940***, R_{lin}=0.911***, F=440).

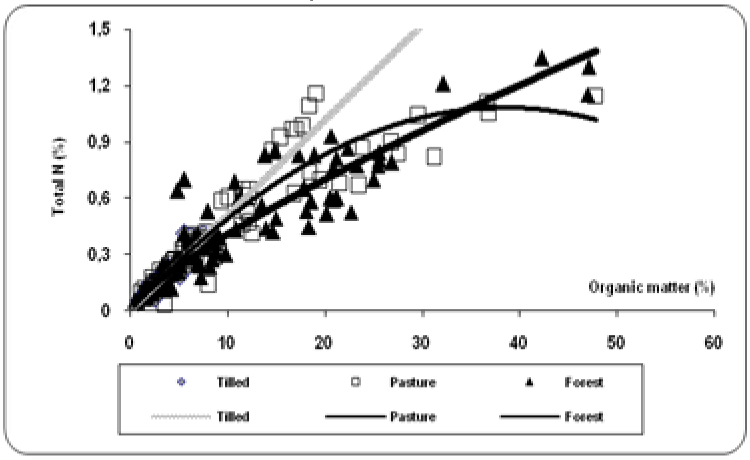

Fig. 2 Relationship between total nitrogen and organic matter

As climate conditions and human activity (agricultural technology) change ratio of intensities processes of humification and mineralisation of dead plant debris on the soil surface and its upper horizons (zoogene debris, roots and microorganisms). Thus, the increase of temperature produces an increase of biological activity and mineralisation accompanied by a decrease of organic matter content (Fig. 3) as shown for example relationship between organic material and temperature of the warmest month, July (n=276, R=0.634***, R_{lin}=0.611***, F=163). This decrease is pronounced for natural grassland ecosystems (n=82, R_{exp}=0.630***, R_{lin}=0.621***, F=50.2) and forestry (n=92, R_{pow}=0.497***, R_{lin}=0.452***, F=23.1) and low for agricultural ecosystems (n=102, R_{poly}=0.177, R_{lin}=0.169, F=2.93) where the two variables are not correlated each with other and representative points are grouped into a small space under 4.6% organic material and temperature over 17 ^{0}C.

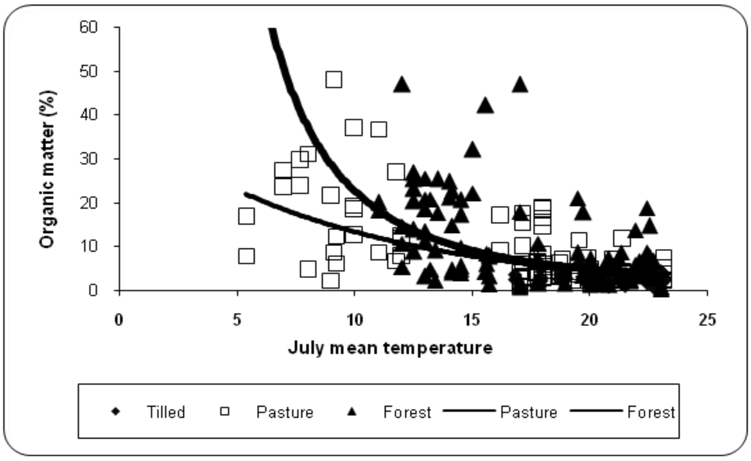

Fig. 3 Organic matter content versus July mean temperature

Group of agricultural ecosystems contains mostly most productive soils, chernozems, but his samples are correlates only with aridity index and not with average temperatures and annual rainfall and natural ecosystems groups are significantly correlated with all climate data. This suggests that the agricultural technologies used could produce changes in the processes of humification and mineralisation of organic material, so the group of agricultural ecosystems was investigated in detail, dividing its samples into three categories: chernozems, luvic phaeozems and luvisols.

At chernozem (n=42, R_{poly}=0.196, R_{lin}=0.121, F=0.98) and luvic phaeozems (n=34, R_{exp}=0.147, R_{lin}=0.079, F=0.97), organic material did not correlate with aridity index, only to luvisols (n=26, R_{poly}=0.772***, R_{lin}=0.574***, F=8.01), because agricultural technologies, including irrigation, changed the upper horizon of soils with a relatively low eluviation.

Besides, all three types of tilled soils have different representing curves (Fig. 4).

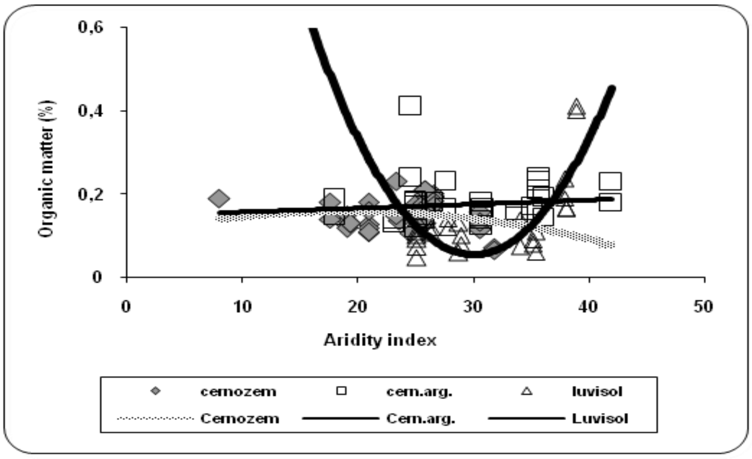

Fig. 4 Organic matter content of agricultural ecosystems as a function of aridity index

Accumulation of organic material in the horizons surface of soils produce a high porosity, allows oxygen diffusion from the air in soil pores, increases mineralisation, alteration of minerals and increases eluviation of ions released into soil solution. Therefore, organic matter content correlates closely with bulk density (n=276, R_{exp}=0.762***, R_{lin}=0.690***, F=249) and the amount of organic material decreases with bulk density and consequently with porosity (Fig. 5).

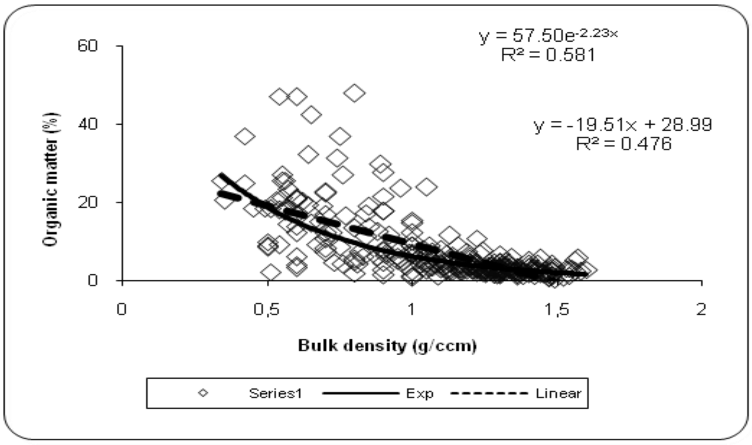

Fig. 5 Correlation between organic matter content and bulk density

Analyzing relations between total phosphorus and total nitrogen (Fig. 6) for the three types of studied ecosystems, when it is observed that natural grassland ecosystems (n=22, R_{poly}=0.805***, R_{lin}=0.785***, F=26.8) and forestry (n=62, R_{poly}=0.788***, R_{lin}=0.777***, F=112), were much higher correlation coefficients than agricultural ecosystems (n=62, R_{poly}=0.404***, R_{lin}=0.390**, F=10.8). The position of these points in the same area suggest that the nature of the mineralisation process is the same in all ecosystems but their intensity depends on the climatic conditions, agricultural technologies used and rise a quantity of phosphorus with yields, every year.

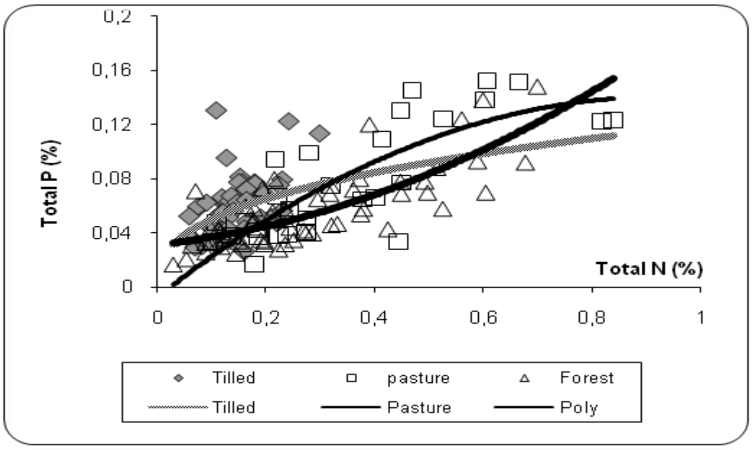

Fig. 6 Total P content as a function of the total N content

CONCLUSIONS

Statistical calculations are useful to investigate the influence of climatic conditions on the evolution of soil profiles. Overall, annual average temperatures correlate closely with average temperatures of the warmest month (July) and coldest (January) and increases the mineralisation of organic material, total nitrogen and total phosphorus content. But, increasing annual precipitation and aridity index increased accumulation of organic material, reducing its mineralisation and increased eluviation of release ions and clay-humus colloids.

Accumulation of organic material, especially like moder, causes a lower bulk density and therefore a higher porosity horizons that emphasizes eluviation ions formed by mineralisation process and clay-humus plasma.

Total nitrogen is mostly bound to organic matter and total phosphorus inherited from the parent material is retained by plants and microorganisms and coordinative related by organic material from surface horizons of soils.

BIBLIOGRAPHY

Crăciun C. Analize mineralogice de fracţiuni argiloase. Publ. SNRSS, nr. 20 (1983), nr. 22 (1985), nr. 25 (1988), nr. 27 (1994), nr. 29 (1997), nr. 30 (2000), nr. 35B (2006).

Florea N., Munteanu I., Rapaport C., Chiţu C., Opriş M. Geografia solurilor României. Ed. Ştiinţifică, 1968.

Florea N., Munteanu I. Sistemul Român de Taxonomie a Solurilor (SRTS). Ed. Estfalia, Bucureşti, 2003.

Gâţă Gh., Mihalache M., Udrescu S., Ilie L. Agricultura durabilă şi procese ireversibile în soluri. Lucr. Şt., USAMV Bucureşti, Seria A, Vol. XLIX, 2006.

Gâţă Gh., Udrescu S., Mihalache M., Ilie L., Muşat M. Procese fizico-chimice la solul brun argiloiluvial de la Sânandrei (Timiş). Publ. SNRSS, nr. 34B, Timişoara, Vol. 2, 2005.

Gâţă Gh., Udrescu S., Mihalache M., Ilie L. Proprietăţi ale solului care influenţează formarea talpei brazdei. Lucr. Șt., USAMV București, Seria A, Vol. L, 2007.

Ilie L., Dumitru M., Mihalache M. Influenţa agriculturii organice asupra potenţialului productiv al solurilor. Lucr. Şt., USAMV Bucureşti, Seria A, Vol. XLIX, 2006.

Ilie L., Mihalache M., Gâţă Gh. Research concerning the estimation methods of the parent material stratifications. Scientific Papers, Faculty of Agriculture, University of Agricultural Sciences and Veterinary Medicine of the Banat, Timişoara, Vol. 40(2), 2008.

Ilie L., Mihalache M., Marin D.I., Gâţă Gh. Accumulation and mineralisation of organic matter in Romanian soils. Scientific Papers, USAMV Bucharest, Series A, Vol. LII, 2009.

Mihalache M., Ilie L. Influence of soil's organic matter upon microelements mobility. Bulletin USAMV-CN, 66(1), 2009.

Mihalache M., Gâţă Gh., Ilie L., Marin D.I., Puicea Brândușa. Oxidation of clay minerals with oxygenated water. Scientific Papers, USAMV Bucharest, Series A, Vol. LII, 2009.

Mihalache M., Ilie L., Marin D.I. Research concerning the evolution of physical and chemical properties of reddish preluvosoil from Moara Domneasca. Scientific Papers, USAMV Bucharest, Series A, Vol. LIII, 2010.