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DETERMINATION OF ORGANIC CARBON IN FOREST SOILS BY COMPARATIVE ANALYSIS OF METHODS: WALKLEY BLACK METHOD WITH THE GOGOASA MODIFICATION VERSUS DRY COMBUSTION DUMARS METHOD

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Abstract: *The present work aims at comparative analysis the analytical methods used for determining organic carbon and total nitrogen in forest soil to assess the status of soil fertility through C/N ratio on the number of samples collected from different regions. In this article were studied 504 soil profile (1940 horizons), soil samples were collected from hills and mountains zone of Romania. The following parameters are analyzed: pH, organic C and total N. The pH was electrochemically determined in calcium chloride, organic carbon was determined by wet oxidation method and dosage titration - Walkley Black method with the Gogoasa modification and dry combustion Dumars method. Total nitrogen in the soil was determined by wet digestion method and dosage titration - Kjeldahl method and dry combustion Dumars method. The results were grouped on the following horizons categories: A, A/x, E, B. Analytical results shows that, given the differences in soil type with soil-specific soil characteristics and the method used in the determination. C/N ratio is different depending on soil type, distinct variance analysis shows significant differences when using Tru Spec CN analyzer. When applied wet mineralization, analysis of variance indicated for most samples analyzed very distinct significant influence of the type of soil C/N ratio. Organic carbon and total nitrogen shows a positive correlation with increasing altitude, because soils are high content in both elements. Dry combustion method using Tru Spec Leco CN analyzer is more efficient and faster time for a sample is 7 minutes allows the simultaneous analysis of carbon and total nitrogen in the soil sample being analyzed. On soils with carbonates, the analyzer is determined inorganic and organic carbon and thus is not necessary to still further analysis. Reaction forest soils are influenced by the distribution of the relief. Organic carbon content is in close contact with major bioclimatic zones: the mountain zone appears highest values, while values occur in the medium and low hill. Total nitrogen content is very close to the geographical distribution of carbon.*

Key words*: organic carbon, total nitrogen, forest soil, C/N ratio*

INTRODUCTION

Soils contain carbon (C) in both organic and inorganic forms. The term soil organic matter (SOM) is used to describe the organic constituents in the soil. The term 'soil organic carbon' refers to the C occurring in the soil in SOM. Naturally-occurring organic carbon forms are derived from the decomposition of plants and animals. In soils and sediments, a wide variety of organic carbon forms are present and range from freshly deposited litter to highly decomposed forms such as humus [1]. Ecosystem carbon (C) and nitrogen (N) cycles are strongly coupled [1, 2]. In recent years, C storage in forest ecosystems has attracted significant research attention because of its potential role as a C sink from the atmosphere. Many studies have attempted to estimate C and N in ecosystem components such as vegetation, forest floor and soil [5, 12]. However, these studies have experienced considerable difficulties and uncertainties due to site-specific characteristics, inconsistent methodologies and definitions. Therefore, more studies with accurate quantification are required to evaluate potential C and N storage in forest ecosystems to improve our understanding of the global C and N balance. In general, stand development is related to C and N storage over the entire life cycle of forest ecosystems because tree growth and mortality rates vary greatly with stand age [3,13].

Nitrogen cycling in forest soil can be described as an internal cycle including mineralization, nitrification and immobilization by microorganisms, root uptake and litter turnover [7]. Mineralization and nitrification rates have been related to numerous watershed characteristics. In addition to soil properties such as the C/N ratio, these include topography [6,14].The amount of nitrogen in the soil C/N ratio and are used as indicators to estimate the carbon from the soil of seizure [1]. Studies on carbon and nitrogen content in the profile you get inches of soil have shown a lower effect of the type of stand [11].

MATERIALS AND METHODS

1. Study area

This study was conducted in Romania, we studied 504 profiles, 1940 horizons, soils samples were collected from hills and mountains zone.

Fig. 1 The plots location investigated

2. Soil analysis

The methodology for soil sampling is: the soil samples were gathered on genetic horizons, after digging the soil profile. For each soil horizon, 1 kg of soil was gathered. Two samples from different depths were gathered for the horizons that are larger than 20 cm. Preparation of soil samples is based on the ISO 11464 method [8].

Collected samples should be transported to the laboratory as soon as possible and be air dried or dried at a temperature of 40 °C. They can then be stored until analysis.

The soils pH was electrochemically determinate in calcium chloride, the reading being fulfilled with Thermo Orion 3 pH- meter. The humus from de soil was established through the humid oxidation method and tritimetical dosage the Walkey Black method with the Gogoasa modification. The organic carbon was determined though the dry ignition method by using the Leco Tru Spect CN automatic analyzer [9].The total nitrogen from de soil was established through the humid mineralization method and titrimetrical dosage-Kjeldahl method with the Gerhard mineralization and still [15].

RESULTS AND DISCUSSIONS

The results regarding in the 504 profiles that have high soil samples were used to determine and calculate C/N ratio by the two methods under comparison, dry combustion method, respectively wet digestion method (organic C by wet oxidation after Walkley - Black – Gogoasa change method and total N by the Kjeldahl method). The results indicate differences in soil type data such specific soil characteristics of soil and the method used in the determination.

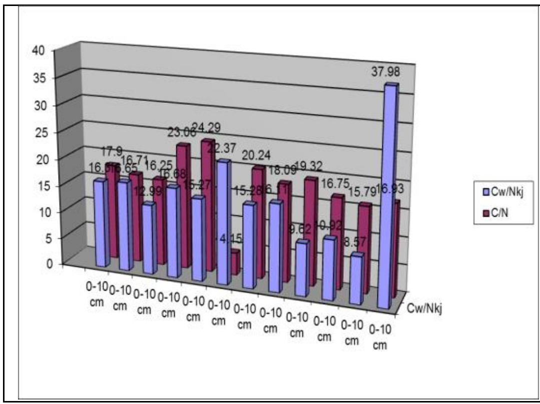

Fig.2 Variation of C/N ratio at Eutricambosoils.

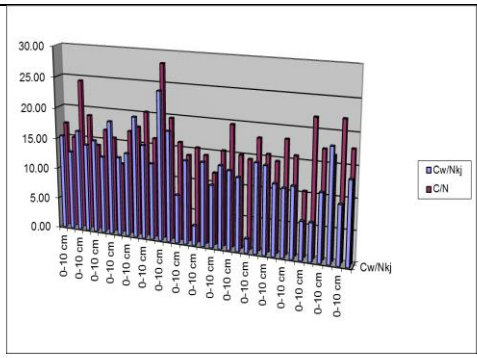

Fig.3 Variation of C/N ratio at Districambosoils.

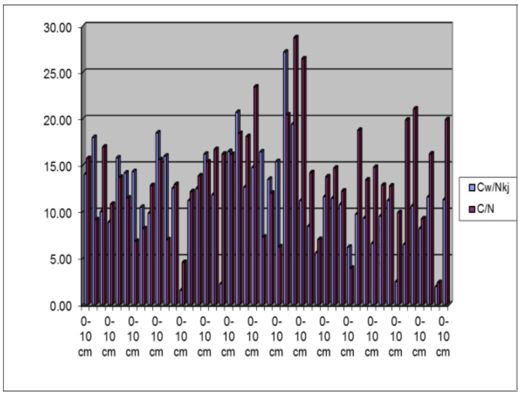

Fig. 4 Variation of C/N ratio at Luvosoils

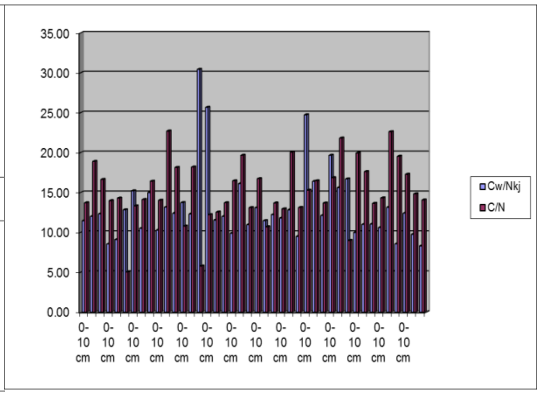

Fig. 5 Variation of C/N ratio at Preluvosoils

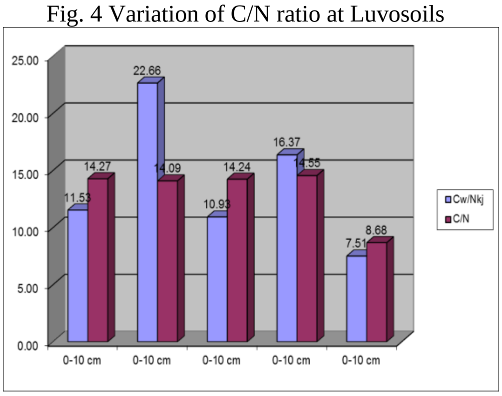

Fig. 6 Variation of C/N ratio at Aluviosoils

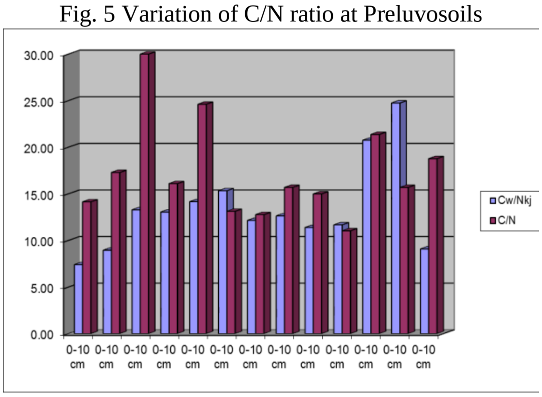

Fig. 7 Variation of C/N ratio at Faeoziom.

The correlation between the results obtained by the two methods of determining the N and Ct is about significant, linear function is described by equations. Which allows the experimental determination of N and Ct by a method to calculate the results obtained by other methods. Applying this correction can be made for a series of soil samples containing the N and Ct very different, depending on the content of N and Ct characterized each soil type.

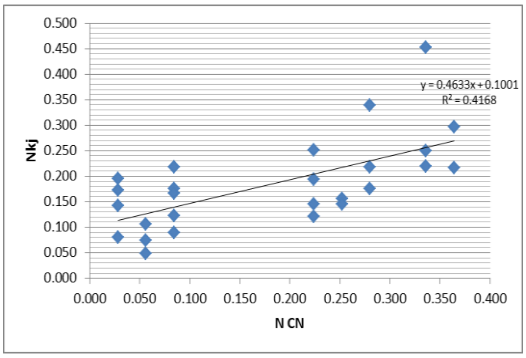

Fig. 8. Correlation between N-CN and Nkj for Eutricambosoils

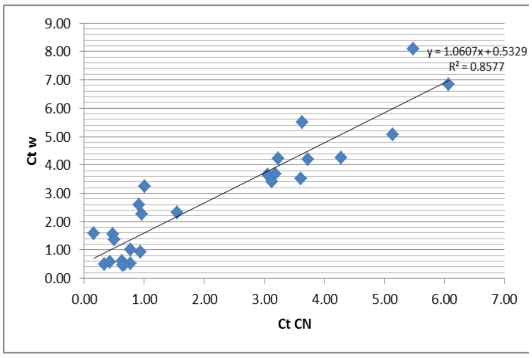

Fig. 9. Correlation between Ct-CN and Ctw for Eutricambosoils

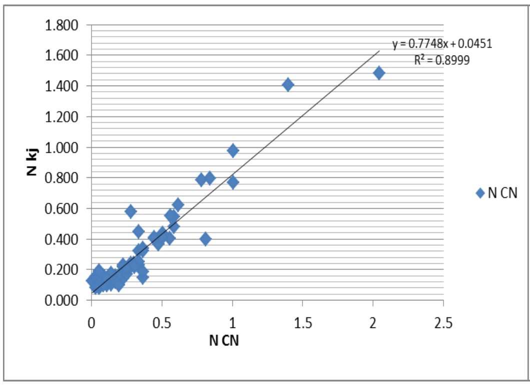

Fig. 10. Correlation between N-CN and Nkj for Districambosoils

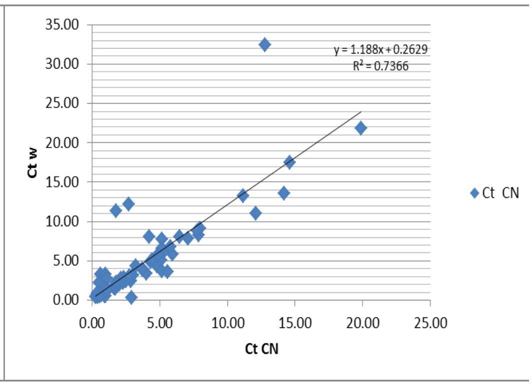

Fig. 11. Correlation between Ct-CN and Ctw for Districambsoils

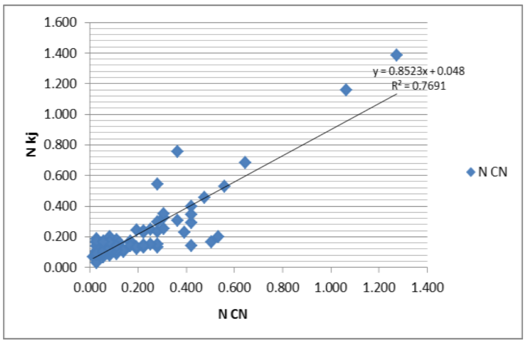

Fig. 12. Correlation between N-CN and Nkj for Luvosoils

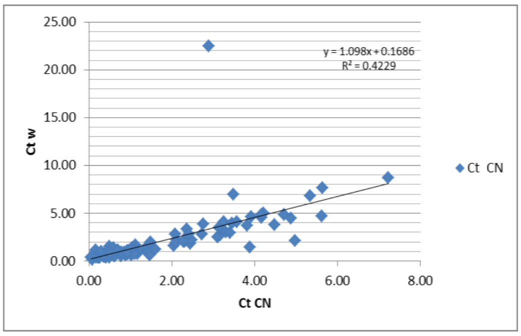

Fig. 13. Correlation between Ct-CN and Ctw for Luvosoils

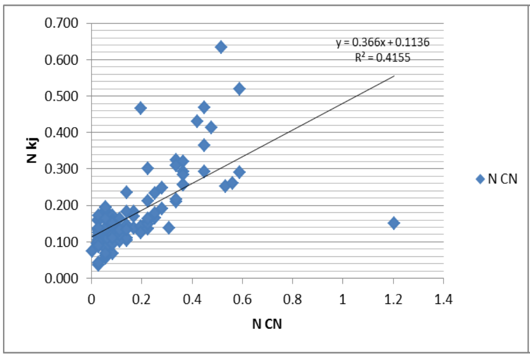

Fig. 14. Correlation between N-CN and Nkj for Preluvosoils

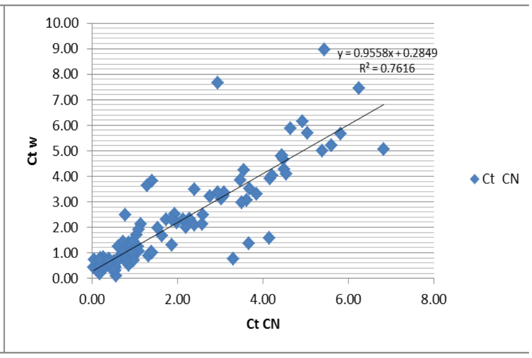

Fig. 15. Correlation between Ct-CN and Ctw for Preluvosoils

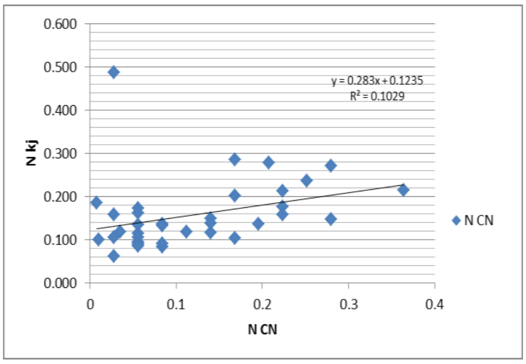

Fig. 16. Correlation between N-CN and N-kj

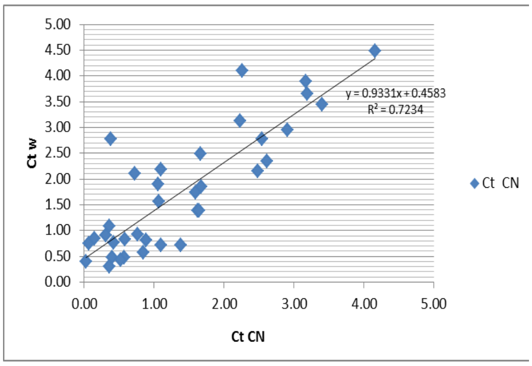

Fig. 17. Correlation between Ct-CN and Ctw for Aluviosoils

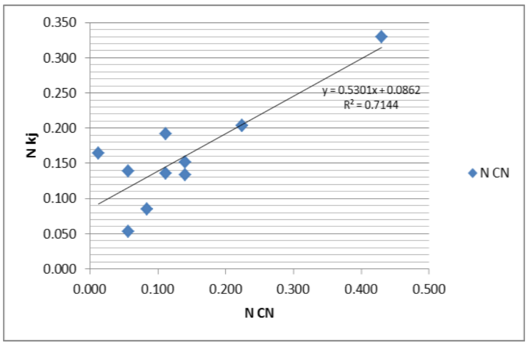

Fig. 18. Correlation between N-CN and Nkj for Faeoziom

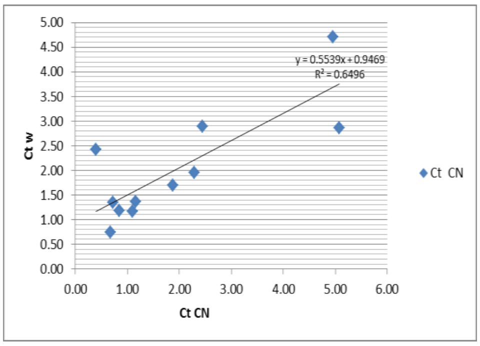

Fig.19. Correlation between Ct-CN and Ctw for Faeoziom

C/N ratio is different depending on soil type, distinct variance analysis shows significant differences when using dry combustion method.

When applied wet mineralization, analysis of variance indicated for most samples analyzed very distinct significant influence of the type of soil C/N ratio and insignificant for preluvosoil.

CONCLUSIONS

When applied wet mineralization, analysis of variance indicated for most samples analyzed very distinct significant influence of the type of soil C/N ratio. Organic carbon and total nitrogen shows a positive correlation with increasing altitude as altitude, soils become richer in both elements.

Dry combustion method using Tru Spec Leco CN analyzer is more efficient and faster time for a sample is 7 minutes allows the simultaneous analysis of carbon and total nitrogen in the soil sample being analyzed.

On soils with carbonates, the analyzer is determined inorganic and organic carbon and thus is not necessary to still further analysis.

Reaction forest soils are influenced by the distribution of the relief. Organic carbon content is in close contact with major bioclimatic zones: the mountain appears highest values, while values occur in the medium and low hill. Total nitrogen is very close to the geographical distribution of carbon.

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BIBLIOGRAPHY

1. AKSELSSON, C., BERG, B., MEENTEMEYER, V., WESTLING, O., 2005: Carbon sequestration rates in organic layers of boreal and temperate forest soils — Sweden as a case study. Global Ecol. Biogeogr. 14, pp. 77 – 84
2. BRIAN A. SCHUMACHER. 2002, Methods for the determination of total organic carbon (toc) in soils and sediments, United States Environmental Protection Agency Environmental Sciences Division National Exposure Research Laboratory
3. BINKLEY D. 2001, A hypothesis about the interaction of tree dominance and stand production through stand development. For Ecol Manag, 2004, 190: 265–271 7
4. COOLS N., De Vos B., 2010, Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests, Part X, ICP Forests, Belgium
5. DAVIS M R, ALLEN R B, CLINTON P W., 2003, Carbon storage along a stand development sequence in a New Zealand *Nothofagus* forest. For Ecol Manag, 2003, 77: 313–321
6. FISK, M.C., SCHMIDT, S.K., SEASTEDT, T.R., 1998, Topographic patterns of above- and belowground production and nitrogen cycling in alpine tundra. Ecology 79, 2253–2266.
7. HART, S.C., STARK, J.M., DAVIDSON, E.A., FIRESTONE, M.K., 1994, Nitrogen mineralization, immobilization, and nitrification. In: Weaver, R.L. (Ed.), Methods of Soil Analysis, Part 2. Soil Sci.Soc. Am.
8. ISO 11464. 1994, Soil Quality – Pretreatment of samples for physic - chemical analysis.International Organization for Standardization. Geneva, Switzerland. 9, p. (available at www.iso.ch)
9. LECO 1996, CNS-2000 Elemental Analyzer - Instruction Manual
10. MIHALACHE M., 2006, Pedologie – geneză, proprietăţile şi taxonomia solurilor. Editura Ceres, Bucureşti;

11. NORDEN, U., 1994, Influence of broad-leaved tree species on pH and organic matter content of forest topsoils in Scania, South Sweden. Scand. J. For. Res. 9, pp. 1 – 8.
12. PREGITZER K S, EUSIRCHEn E S. Carbon cycling and storage in world forests: biome patterns related to forest age. Glob Change Biol, 2004, 10: 1–26
13. TAYLOR A R, WANG J R, CHEN H Y H., 2007, Carbon storage in a chronosequence of red spruce (*Picea rubens*) forests in central Nova Scotia, Canada. Can J For Res, 2007, 37: 2260–2269
14. ZAK, D.R., HAIRSTON, A., GRIGAL, D.F., 1991, Topographic influences on nitrogen cycling within an upland pin oak ecosystem. For. Sci. 37, 45–53.
15. ***1981- Metodologie de analiză agrochimică a solurilor în vederea stabilirii necesarului de amendamente şi îngrăşăminte partea I, Bucureşti.