DOI: 10.22620/agrisci.2016.20.034

СТАТИСТИЧЕСКИ АНАЛИЗ НА ПОКАЗАТЕЛИ НА КАНЕЛЕНИ ГОРСКИ ПОЧВИ В ОБЛАСТ СТАРА ЗАГОРА
STATISTICAL ANALYSIS OF SOME SOIL PARAMETERS FROM LUVISOILS IN THE REGION OF STARA ZAGORA

Рада Попова[1], Мима Тодорова[2], Димитър Кехайов[1]
Rada Popova[1], Mima Todorova[2], Dimitar Kehayov[1]

[1] Аграрен университет – Пловдив
[2] Тракийски университет, Агрономически факултет, Стара Загора
[1] Agricultural University – Plovdiv
[2]Trakia University, Agricultural faculty, Stara Zagora

E-mail: radapopova@abv.bg

Abstract

The basic soil indicators were determined – pH, humus, mechanical composition of subtypes cinnamon forest soils in the region of Stara Zagora. The relationship between them was searched for through the methods of regression analysis. In the present study data for pH, organic carbon content, organic nitrogen, available phosphorus, potassium content and clay content for 47 soil samples were used (Gleic Chromic Luvisols). The studied soil samples were characterized by an acid to alkaline reaction with a wide range of pH (H_2O) values between 5.9 and 7.6, the average value was 6.6, the clay content between 38.0 and 45.0 %, with low to high humus content – between 1.25 and 5.4% and from low to high organic nitrogen content – between 6.6 and 60.20 mg/kg with an average value of 30.36. A high correlation between the organic nitrogen content, mg/kg and K_2O, mg/100 g with R=0.64 (Fig. 3) was found; between the humus, % and organic nitrogen content, mg/kg with R = 0.58 (Fig.4) and between the humus content and K_2O, mg/100 g with R=0.55. A low correlation between the available phosphorus and potassium with R<0.33 was established. On the basis of humus, % and pH values for soil samples a principal component analysis was performed to understand the distribution of soil samples in multimensional space. Five clusters (groups) were specified in advance. After performing the factor analysis it was found that 86.62% of the variations of pH values were based on the modification of the content of humus. A statistical model for the relationship between humus and pH was developed.

Key words: soil parameters, statistical analises.

INTRODUCTION

Soil organic matter (SOM) improves physical and chemical soil properties, soil structure, enhance aeration and water penetration, increases water holding capacity and stores and supplies nutrients for growth of both plants and soil microorganism. The pH is also one of the most important soil parameter, which governs most of the soil physicochemical properties such as nutrient availability, microbial activity, organic matter transformations, soil micro structural properties and many others. The determination of pH values of soil is rapid and non-expensive method. The macronutrients-nitrogen, phosphorus and potassium (NPK), represent three of the most important nutrients in agriculture practice. Soil fertility is conventionally evaluated by soil properties such as SOM, nitrogen, phosphorus and potassium contents. The methods of miltivarite statistics are powerful tools for the integrated assessment and can help soil researchers to extract much more information from the soil data. (Sena et al., 2002; Popova and Kehayov, 2011; Ramadan et al., 2005). The modern chemometrics is a branch of chemistry (very often related to analytical chemistry) which deals with the application of mathematical and statistical methods in order to evaluate, classify, model, and interpret chemical and analytical data, to optimize and model chemical and analytical processes and experiments and to extract a maximum of chemical and analytical information from experimental data (Simeonov et al., 2010; Mostert et al., 2010).

The aim of present study was on determination of relationship between some soil parameters in Gleic Chromic Luvisols from Stara Zagora region by using chemometrics techniques.

MATERIALS AND METHODS

In the present study were used data for pH, organic carbon content, organic nitrogen, available phosphorus, potassium content and clay content for 47 soil samples - Gleic Chromic Luvisols, (WRBSR, 2006). The values of organic carbon content was calculated into humus content.

More detailed information about morphological and chemical properties about studied soil type Gleic Chromic Luvisols was reported in our previous investigation Todorova and Popova (2009).

Chemometrics was used to establish relationship between the studied soil properties in the Luvisols soil samples. Principal component analysis (PCA) was applied to the experimental data to assess relationship between values of pH and humus content in soil samples and distribution of the samples in multimensional space. Cluster analysis (K-means methodology) was performed to understand the distribution of samples with regard to values of humus content and pH of soil samples. Chemometrics was carried out by Unscrambler X 10.2 (CAMO Software AS, Norway).

RESULTS AND DISCUSSION

The studied soil samples were characterized with acid to alkaline reaction with wide range of pH (H_2O) values between 5.9 and 7.6, the average value was 6.6, clay content between 38.0 and 45.0 %, with low to high humus content between 1.25 and 5.4% and from low to high organic nitrogen content between 6.6 and 60.20 mg/kg with average value 30.36. (Fig. 1).

The samples also characterized with low available phosphorus content between 2.1 and 4.2 mg/100 g and high available potassium content with more than 12.5 mg/100g (Fig. 2).

The wide range of pH, humus, organic nitrogen and available potassium content was because of different soil depths if soil sampling from 0-20 and 40-60 cm and the second reason could be different land using in the experimental field of Trakia University, Stara Zagora, where the samples were collected. It was found a high correlations between Organic nitrogen content, mg/kg and K_2O, mg/100 g with R=0.64 (Fig. 3); between Humus, % and Organic nitrogen content, mg/kg with R = 0.58 (Fig.4) and between Humus content and K_2O, mg/100 g with R=0.55. It was established low correlations between available phosphorus and potassium with R<0.33.

On the base of Humus, % and pH values for soil samples Principal component analyses and was performed to understand the distribution of soil samples in multimensional space (Fig. 5).

On the basis of PC analysis result non-hierarchical clustering via K-means methodology was applied to group the samples based on their similarity with regard to Humus, % and pH values. Five clusters (groups) were specified in advance.

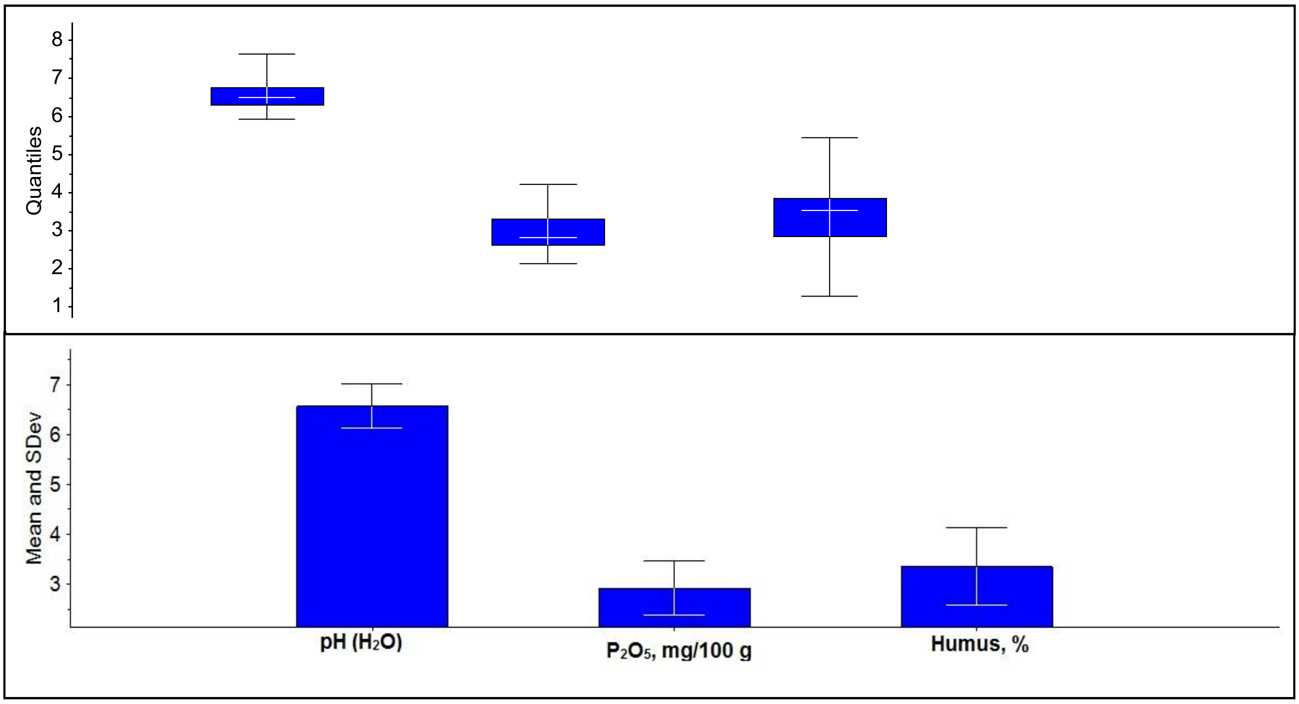

Fig. 1. *Statistical details of pH (H_2O), P_2O_5, mg/100 g and Humus content, % in the studied soil samples*

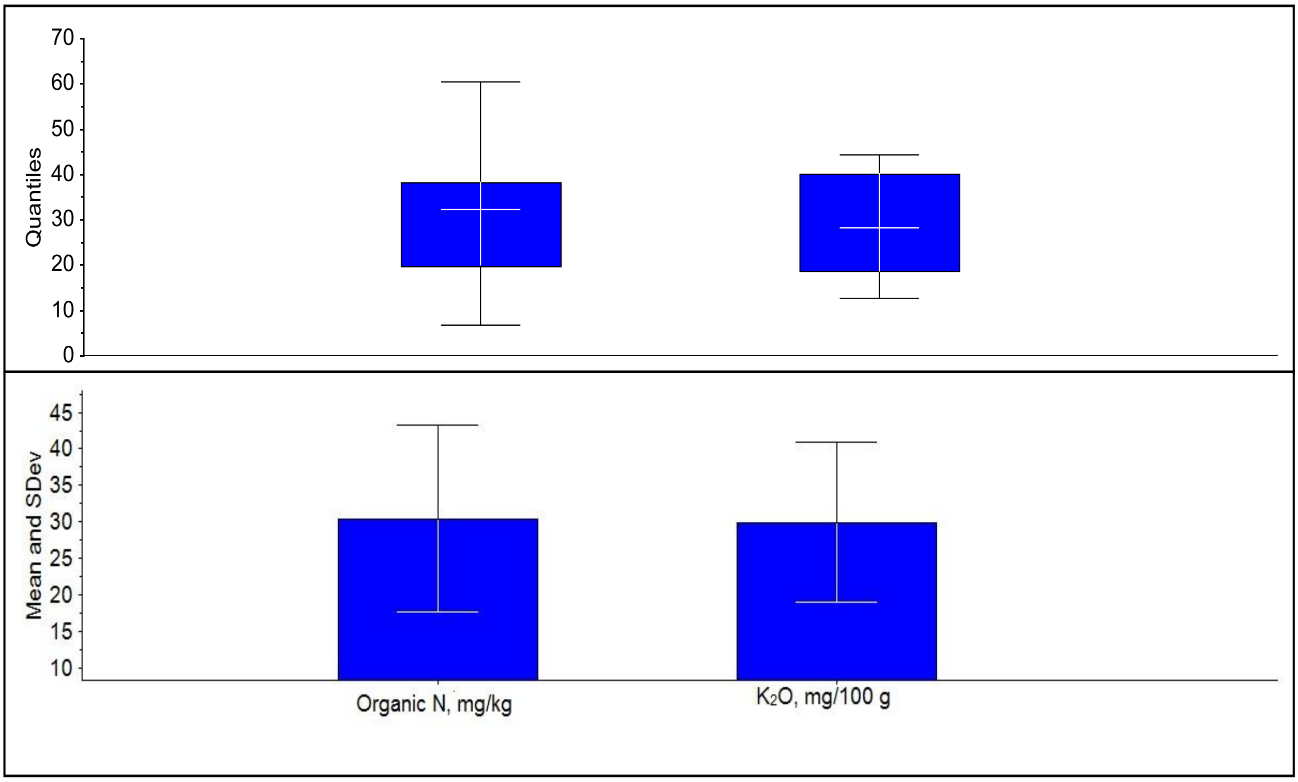

Fig. 2. *Statistical details of Organic N, mg/kg and K_2O, mg/100 g in the studied soil samples*

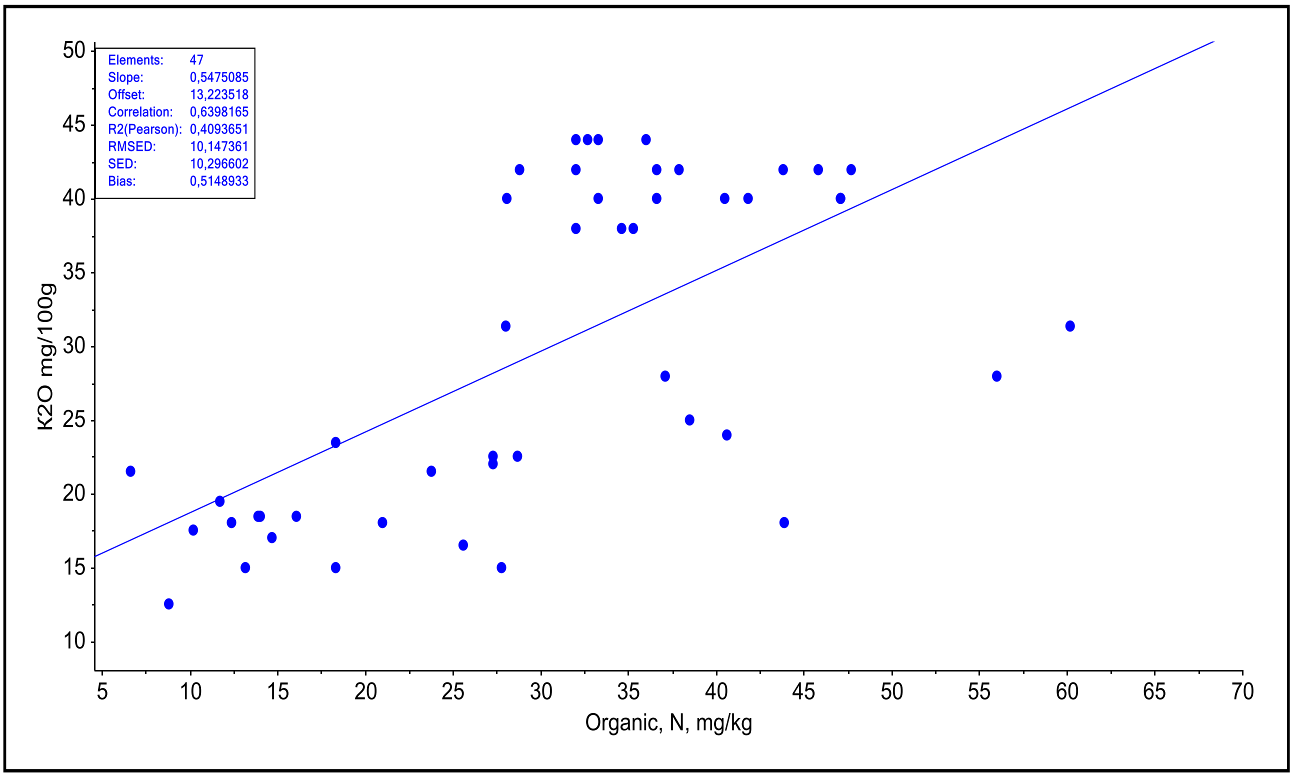

Fig. 3. *Relationship between Organic nitrogen and K_2O, mg/100 g values in the soil samples*

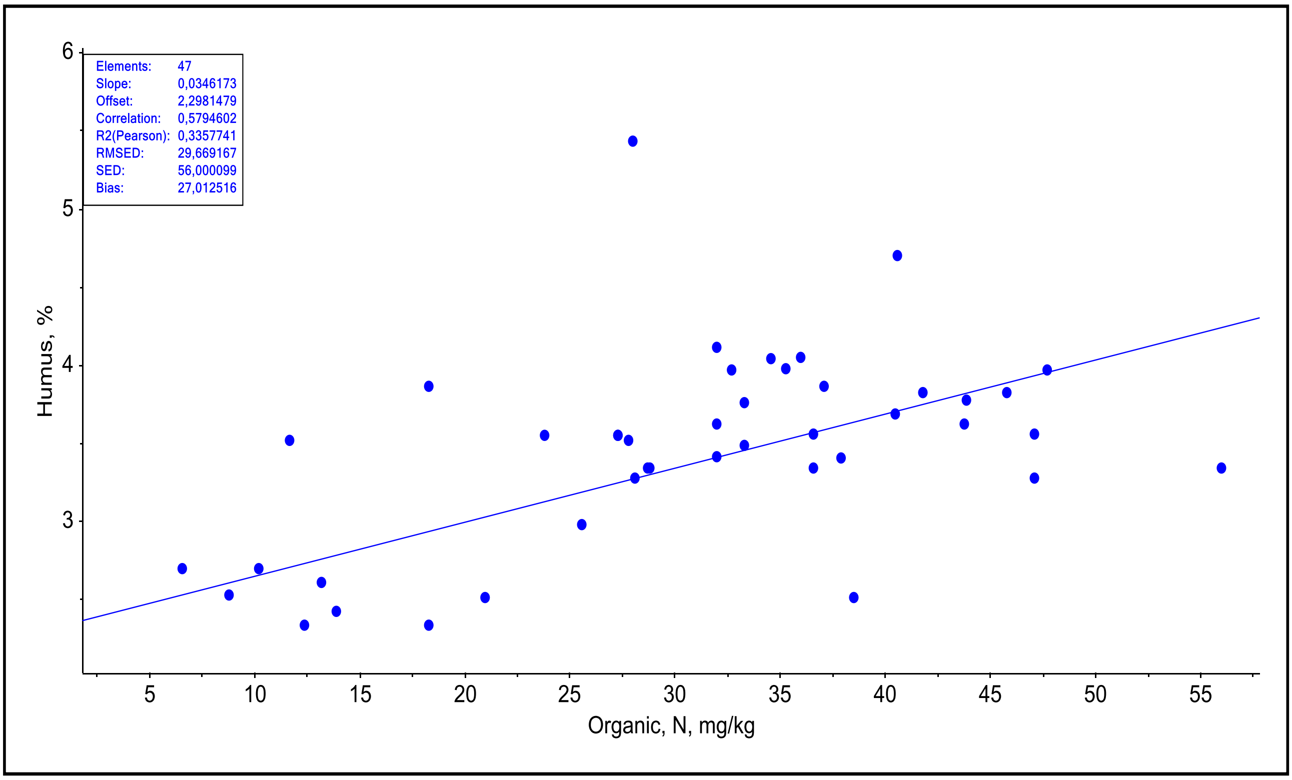

Fig. 4. *Relationship between Humus, % and Organic nitrogen, mg/kg in the soil samples*

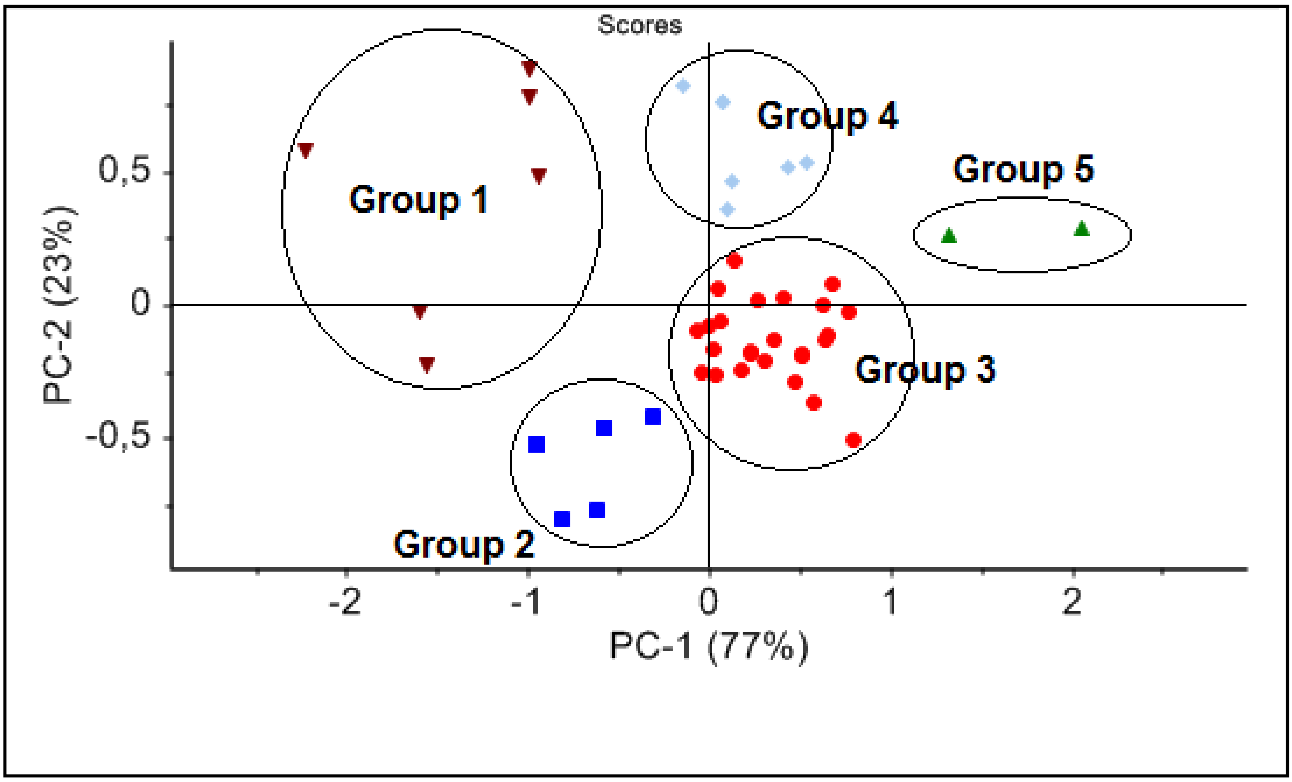

Fig. 5. *Scores plot of the soil samples*

Factor 1 explained 77 % of data variance and Factor 2 – 23% separated five groups of soil samples clearly. PC1 described variable – Humus content and PC2 – pH (H_2O), therefore Humus content is dominant soil parameter for groups formation than pH. Group 1 and Group 5 occupied distinctly opposite areas from each other in multimensional space. Soil samples belonging to group 1 were with lowest humus content and samples belonging to Group 5 were with highest humus content. Groups 2 and 4 also occupied different areas opposite from each other. The samples belonging on Group 2 were with acid reaction in compare to samples from Group 4, that were with neutral to alkaline reaction. There was also difference between humus content in the samples including in the both Groups (Table 1).

The results from factor analysis are presented in Table 2.

It was found that 86,62% from the pH values variation was on the base variation of humus content. On that reason in the present study was developed calibration model (equation) such as:

$$pH = f(humus) \quad (1)$$

The statistical data obtained from regression analysis were presented Table 3.

The calibration equation developed for relationship between pH and Humus content in the studied soil samples.

$$pH = 6,67*X-2,05*X^2+0,195*X^3$$

Table 1. Cluster analysis of soil samples based on Humus, % and pH values

Range	Group 1	Group 2	Group 3	Group 4	Group 5
Humus, %	1.25 - 2.5	2.3 - 3.0 3.3 - 4.1	3.4 - 4.0	4.7 - 5.4	
pH (H_2O)	6.6 -7.6	5.9 - 6.2	6.0 - 6.6	6.9 -7.4	6.5 - 6.6

Table 2. Factor analysis of the influence of soil characteristics on pH

Factor Loadings (Unrotated) (pH), (Marked loadings are >0,700000)				
	Factor 1 Factor 2			
Humus, %	-0,2932		0,9265	
Clay content, %	0,7740		0,3973	
pH (H_2O)	0,8446		-0,0424	
Expl.Var.	1,3985		1,0180	
Prp.Total	0,4661		0,3393	
Eigenvalues (SZ) Extraction: Principal components				
	Eigenvalue	% Total	Cumulative variance	Cumulative Eigenvalue %
Humus, %	1,3985	86,6181	1,3985	86,61815
Clay content, %	1,0180	13,3818	2,4166	100,0000

Table 3. Statistical data from regression analysis

Regression Summary for Dependent Variable: *pH = f (humus)* R = 0,99650976; R^2 = 0,99303170; Adjusted R^2 = 0,99250907; F (3,40) = 1900,1; p<0,00001						
	Beta	**Std.Err.**	**B**	**Std.Err.**	**t(40)**	**p-level**
X	3,41828	0,205213	**6,69954**	0,402199	16,65725	0,000000
X^2	-3,90108	0,404683	**-2,07628**	0,215385	-9,63985	0,000000
X^3	1,48089	0,212706	**0,19947**	0,028651	6,96214	0,000000

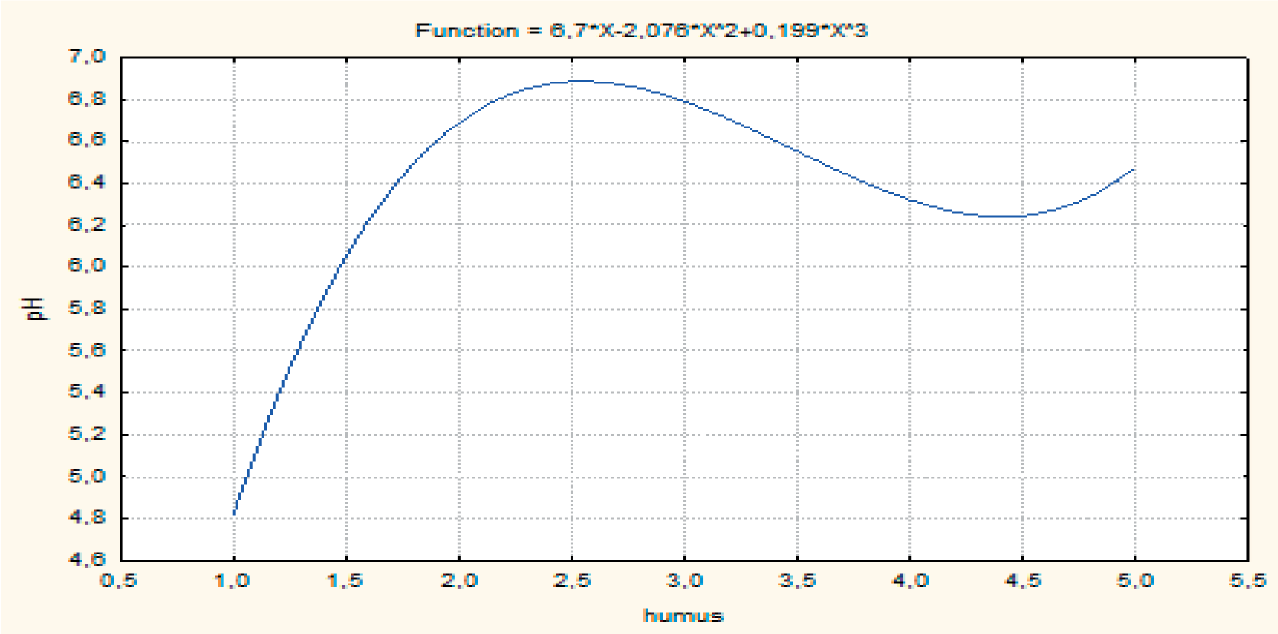

Fig. 6. *The regression model of pH values variation with regard to Humus content, %*

The model obtained is graphically illustrated in the Figure 6.

The regression model showed that values humus content decreased with the decreasing pH values. And when pH values increased the humus content also increased until pH – 6,9. Aciedo Pietri and Brookes (2009) also reported that there were statistically significant relationships between soil pH and biomass C (R^2=0.80), biomass ninhydrin-N (R^2=0.90), organic C (R^2=0.83) and total N (R^2=0.83), confirming the importance of soil organic matter and pH in stimulating microbial biomass growth. The authors explained that microbial biomass and microbial activity tended to stabilise at pH values between about 5 and 7 because of the the differences in organic C, total N and Al concentrations within this pH range were small. Koutev and Katsarova (2011) also reported that the lower values of organic carbon content were related with low pH of soil.

CONCLUSIONS

On the basis of research done, calculations and analysis can draw the following conclusions:

1. On the change of pH at Meadow cinnamon soils of Stara Zagora significantly influenced topsoil. About 86% of the change in pH due to it.

2. Developed efficient model for the relationship between pH and humus in maroon-forest soils in the region of Stara Zagora, which can be used to predict and solve optimization problems.

REFERENCES

Aciedo Pietri, J., P.C. Brookes, 2008. Relationships between soil pH and microbial properties in a UK arable soil. Soil biology and Biochemistry, 40, pp. 1856–1861.

Koutev, V., Katsarova, A., 2011. Spatial Variability of Soil Organic matter in Monitoring Network on Acid Soils. Soil science, agro chemistry and ecology, Supplement № 1–4, pp.147–149.

Mostert, M., Godwin, A., Kokot, S., 2010. *Application of chemometrics to analysis of soil pollutions*. Trends in Analytical Chemistry, 29 (5), pp. 430–445.

Popova, R., Kehayov, D., 2011. Influence of soil parameters on the pH value of soils in North Bulgaria. International Conference – 100 years Buigarian soil science, vol 1, pp. 334–337.

Ramadan, Z., Hopke, Ph., Johnson, M., Scow, K., 2005. Application of PLS and Back-Propagation Neural Network for the estimation of soil properties. Chemometrics and Intelligent laboratory System, 1, pp. 23–30.

Sena, M., Frighetto, R., valarini, P, Tokeshi, H., Poppi, R., 2002. Discrimination of management effects on soil parameters by using principal component analysis: a multivariate analysis case study. Soil and Tillage research 2, pp. 171–181.

Simeonov, V, Simeonova P, Tsakovski S and Lovchinov V, 2010. Lake Water Monitoring Data Assessment by Multivariate Statistics. J. Water Resource and Protection, 2, pp. 353–361.

Todorova, M., Popova, R., 2009. An Assessment rating and land utilization of the some soil units in Stara Zagora region. International Science conference. ISBN 9789549329452, pp. 411–417.