Hódmezővásárhely, 5th May 2011 Conference CD supplement ISSN 1788-5345

AGROCHEMICAL PROPERTIES: SOIL FERTILITY PARAMETERS IN RELATION TO PLANT NUTRITION

FLORIN SALA, DANIELA PÎSLEA

Banat University of Agricultural Sciences and Veterinary Medicine Timişoara,
Calea Aradului, 119, 300645, Timisoara, Romania
florin_sala@yahoo.com

ABSTRACT - Agrochemical properties: soil fertility parameters in relation to plant nutrition
Soil is an environment with a high degree of heterogeneity from the point of view of the content of nutritious elements and of the mobility and bioavailability of these elements for the crops. The studies and research on which the present paper relies aimed at assessing the level of fertility of the agricultural land in the Banat Plain area on which they practice conventional agricultural systems. Research was carried out at the Didactic Station of the Banat University of Agricultural Science and Veterinary Medicine in Timisoara (Romania), in the soil and climate conditions specific to the area of the Banat Plain. The soil within the Didactic Station is a cambic chernozem (cambic phaeozem), poorly gleyed, with a considerable share of the general area (about 85%). Climate conditions can be characterised through multiannual average values, the most important of which are: 603.3 mm precipitations and temperatures reaching 10.9°C. Agro-chemical parameters defining soil fertility and that were studied are: pH, humus content (H), nitrogen index (NI), total nitrogen (N_t), mobile phosphorus (P_{AL}) and available potassium (K_{AL}). The methods with which we determined the studied agro-chemical and fertility indicators are the current ones (colorimetry, atomic absorption spectrophotometry). In order to process the results, we used reference standards for each agro-chemical indicator we studied. Results were characterised within the context of land valorisation through crop rotation with no vegetable crops, which recommends certain reference values in the processing of the results. Soil reaction is within the neuter range, i.e. pH = 7.02. The relatively high degree of saturation in basic cations (V = 85-87%) ensures a good buffering for the pH. Soil stable organic matter content represented by humus has a medium level, i.e. H = 3.2, while the value of the nitrogen index (NI), as a representation of the interaction between H x V, is 2.72. Both values reflect medium soil fertility. The level of mobile phosphorus supply is 23.55 ppm, and the level of assailable potassium is 154.56 ppm. On the whole, among the agro-chemical indicators we studied, soil fertility has a medium level, which asks for fertilisation measures to ensure a high balance between soil and plants allowing high, constant agricultural crops.

Keywords: soil fertility, mineral fertilisers, fertilizer systems, agro-chemical indicators

INTRODUCTION

Plant nutrition is a complex physiological process that involves the taking over, transporting, and metabolising mineral nutrients and some organic compounds necessary for the plant’s growth and development (EPSTEIN AND BLOOM, 2005).

Soil is the main medium of plant growth and nutrition, soil minerals representing the main nutritious sources with variable mobility and bioavailability for the crops (MENGEL & KIRKBY, 2001; HAVLIN *et al*., 2005; BARKER AND PILBEAM, 2007).

Compared to the atmospheric or aquatic environment, soil is a very complex environment. As support and nutrient medium for the plants, soil is a heterogeneous system made up of three phases: solid, liquid, and gaseous and its main agricultural feature is fertility (ELIADE *et al*. 1983; EPSTEIN AND BLOOM, 2005).

The soil features that are important for plant nutrition and that are expressed as different indicators can have rather wide variations in space and time depending on both natural or technological factors (DUMITRU 2002; SALA *et al*. 2010). For instance, soil nitrogen content can have wide variations over a few centimetres and along a single day

(EPSTEIN AND BLOOM, 2005).
Studying and characterising the soil as a nutritious environment for the plants through the prism of soil reaction, soil nutrient content, and nutrient bioavailability is a permanent must in the development and achievement of sustainable agricultural systems (DAVIDESCU AND VELICICA DAVIDESCU, 1972; SANCHEZ *et al*., 1982; SALA, 2008).

MATERIAL AND METHOD

Within our study and research, we assessed soil fertility and soil nutrition potential as a nutritional environment for wheat, maize, and sunflower crops.
The indicators we studied were represented by pH, humus content (H), nitrogen index (NI), total nitrogen (N_t), mobile phosphorus (P_{AL}) and available potassium (K_{AL}).
The methods with which we determined the studied agro-chemical and fertility indicators are the current ones (colorimetry, atomic absorption spectrophotometry).
In order to process the results, we used reference grids for each of the studied agro-chemical indicator.
Result characterisation was done from the perspective of valorising the land through wheat, maize, and sunflower crops that have specific nutrient needs to yield properly. These crops are part of crop rotations with no vegetables, which recommends certain reference values in result interpretation.
The study and research area is specific to the Banat Plain, and the soil is a cambic chernozem sharing about 85% of the entire area.
Climate conditions can be characterised through multi-annual average values: 603.3 mm precipitations and temperatures of 10.9°C.

RESULTS AND DISCUSSION

The studies and research were carried out on a cambic chernozem, poorly gleyed, with a water table located at about 3 to 3.5 m deep in the ground.
Agricultural systems in the area are of the conventional type, i.e. based on cereal crops and on oily technical plants on smaller areas; fertilisation is done with mineral fertilisers.
Soil reaction is neuter (pH = 7.06), which points to a soil with a good buffering capacity that can overtake relatively well the mineral fertilisers applied (*Table 1.*).

Table 1. Soil fertility parameters depending on plant nutrition

	Analysed agro-chemical parameters					
	*p*H	H (%)	IN (%)	Nt (%)	P_{AL} (ppm)	K_{AL} (ppm)
Values of soil indicators	7.06	3.2	2.72	0.127	23.55	154.56
Reference intervals		< 3 3-6 > 6	< 2 2-4 > 4	< 0.10 0.11-0.15 0.16-0.20 0.21-0.25 > 0.25	< 8 8.1-18 18.1-36 36.1-72 > 72.1	< 100 101-150 151-200 201-350 > 350
Significance of soil indicators	Neuter reaction	Average humus content	Average nitrogen index value	Total nitrogen low supply	Average mobile phosphorus supply	Average available potassium supply

The soil reaction was not in a stable balance: there were permanent variations of the pH as a result of the application of substances that hydrolyse acidly or basically, as well as of chemical, physic-chemical, and biological processes in the soil resulting in acids or bases that tend to change soil reaction.
Basic cation saturation degree (V = 85-87%) and total cation exchange capacity (T) make up the buffering capacity of the studied soil which, from an agro-chemical point of view, represents the soil component and specific relationships opposition to the changing of ion concentration in the soil solution (H^+,-OH, $H_2PO_4^-$, K^+, NH_4^+, NO_3^-) as a result of outer action – in his case, mineral fertilization.
Humus content (H = 3.2%), a potential nitrogen reserve for the crops, has a medium significance as indicator of the soil fertility level. This reflects in general the cultivation technology and, in particular, the fertilisation system based almost exclusively on mineral fertilisers, soil organic matter supply being minimally represented only by the crop debris.
The high value of the soil basic cation content (85-87%) determines, together with the humus content, the value of the nitrogen index IN = 2.72 which, on the interpretation scale of the indicator, also points to an average soil fertility level. The value of these indicators provides the soil with good buffering capacity for the pH and for the nutritious ions.
Total nitrogen supply (N_t) reaches 1.12%, which reflects an average supply of the soil with this macro-nutrient. With a low supply of organic matter and with a C/N balance in favour of the carbon (the cellulose matter in the plant debris), the balance between decomposition and mineralisation of the organic matter was lower and plant nutrition was based almost exclusively on the mineral fertiliser supply.
Mobile phosphorus content (P) reached 33.5 ppm, and assailable potassium reached 132.5 ppm.
The movement of phosphate ions is slow because the procedures for fixing versify and low solubility of phosphorus compounds in soil. The maximum distance that can be taken root phosphate ion is 2 mm (*Figure 1.*). The mechanism of diffusion of phosphate ions is crucial for supply to the root phosphorus.

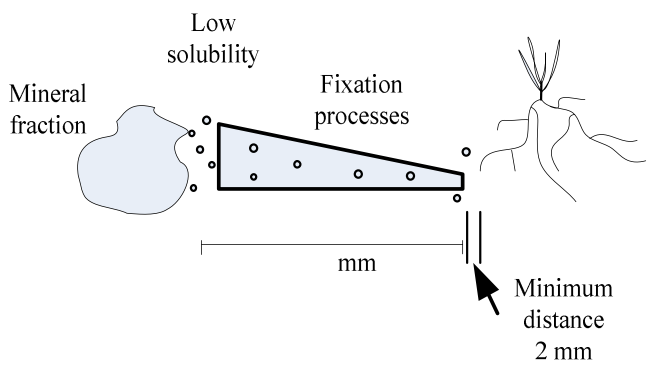

Figure 1. The mobility of phosphate ions in soil - schematic representation.

Most phosphorus in the soil (and faster) is absorbed by plants as a primary ion orthophosphoric $H_2PO_4^-$ and to a lesser extent and reduced speed, the secondary ion orthophosphoric HPO_4^{2-} . These values represent medium supplies with the two macro-

elements; compared to the plant nutrient needs, we need to add differentiated fertilization.
The indicators used in characterising the soil from the point of view of fertility are used both at national and international levels and reference standard values for each of the fertility indicators analysed and presented are national level reference ones.

CONCLUSIONS

Research carried out pointed out the fertility level of the cambic chernozem in a reference area in the Banat Plain where they apply conventional agricultural systems.
Assessment indices of the fertility level and of the yielding potential are the indices usually sued in characterising soil fertility. The values recorded for the indicators analysed reflect the soil fertility state under agricultural conditions.
The value of the pH is within the neuter range (7.02). The relatively high basic cation saturation degree (V = 85-87%) ensures a good buffering for the pH.
Soil stable organic matter content was H = 3.2, and the value of the nitrogen index NI as a representative of the interaction H – V, was 2.72. both values reflect medium soil fertility.
Mobile phosphorus content reached 23.55 ppm, and assailable potassium reached 154.56 ppm. The supply state in these two elements is medium.

ACKNOWLEDGEMENTS

This work was partially supported by the grant POSDRU /21/1.5/G/38347.

REFERENCES

BARKER A. V., PILBEAM D. J. (2007): Handbook of Plant Nutrition. p. 21-23. 51-55. 92-97. CRC Press. SUA.
ELIADE GH., GHINEA L., STEFANIC GH. (1983): Bazele agrochimice ale fertilității solului. p. 15-23. Editura Ceres. Bucuresti.
DAVIDESCU D., VELICICA DAVIDESCU (1972): Testarea stării de fertilitate prin plantă si sol. 45-49. 63-65. 285-295. Editura Academiei. Bucuresti.
DUMITRU M. (2002): Mineral fertilizers and sustainable crop production in Romania. CIEC Proc. Suceava. Bucarest p. 63-75.
EPSTEIN E., BLOOM A. J. (2005): Mineral nutrition of Plants: Principles and Perspectives. p. 243-247. Sinauer Associates. Inc. Publisher. SUA.
MENGEL K. & KIRKBY E. A. (2001): Principles of Plant Nutrition. p. 15. 34. 64. 93. Kluver Academic Publisher. London.
HAVLIN J. L., BEATON JAMES D., TISDALE S. L., NELSON W. L. (2005): Soil fertility and fertilizer. Seventh Edition. p. 298-300. 324-330. Pearson Prentice Hall. SUA.
SANCHEZ PEDRO A., COUTO WALTER., BUOL STANLEY W. (1982): The fertility capability soil classification system: Interpretation, applicability and modification. Geoderma. Volume 27. Issue 4. p. 283-309.
SALA F. (2008): Agrochimie. p. 301-306. 320-326. Ed. Eurobit. Timisoara.
SALA F., RADULOV ISIDORA., CRISTA F., BERBECEA ADINA (2010): The modification of some Agrochemical Soil Indices under the Influence of Mineral Fertilization. Research Journal of Agricultural Sciences. 42 (3) 1 908 (2010). p. 302-305 Editura Agroprint.