SOIL AS NUTRITION ENVIRONMENT IN RELATION TO NUTRITIONAL REQUIREMENTS IN APPLE

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ABSTRACT - Soil as nutrition environment in relation to nutritional requirements in apple
The studies and research on which the present paper relies aimed at assessing the soil in the fruit-tree plantation of the Didactic Station of the Banat University of Agricultural Science and Veterinary Medicine in Timisoara (Romania) as nutrition medium for apple-trees to allow fertilisation schemes that ensure the bioavailability of nutrients and of optimal nutrition. On fruit-tree plantations, soil is of interest in plant nutrition due to its larger edaphic volume over a 0-40 cm depth. Therefore, we carried out the soil analysis and characterisation over the edaphic volume, i.e. over the two levels of interest from the point of view of water and nutrient supply for apple-trees. The soil on the fruit-tree plantation is characterised as a heterogeneous nutrition environment if we take into account the features of the two horizons of nutrient and water supply. The different physicochemical features are due to the acting factors and conditions. Over the horizon 0-20 cm, there is a higher amount of organic matter, higher aeration, and more intense oxidation phenomena; the horizon is subjected to some physicochemical and biological changes. The soil on the fruit-tree plantation is characterized by a neuter reaction in the horizon 0-20 cm (pH = 6.90) and by low acid level over the horizon 20-40 cm (pH = 6.39). Humus content (H) is about 1.95% over the horizon 0-20 cm and 1.73% over the horizon 20-40 cm. Total nitrogen content N_t is 1.16 % and 1.13%, respectively. Mobile phosphorus supply reaches 32.55 ppm in the upper horizon of the soil and 29.4 ppm in the horizon 20-40 cm. Assailable potassium reaches between 172.0 ppm in the upper horizon 0-20 cm and 161.5 ppm in the horizon 20-40 cm. Soil reaction is neuter to low acid, which makes macro-element bio-availability relatively good. There are good conditions for the development of some low-solubility compounds (calcium phosphates), which recommends the supply of mobile phosphorus through proper fertilization.
Keywords: sol, nutrition environment, soil – plant relationship, apple plantation, specific consumption, fertilisation

INTRODUCTION

Soil as nutrition environment on fruit-tree plantations should be analysed and characterised through a larger edaphic volume subdivided into two water and nutrient supply levels (0-20 cm and 20-40 cm). The vast root system of fruit-tree species explores a larger volume of soil, with favourable water and nutrient conditions.
Characterisation of soil as a nutrition environment for apple plantations should be done over two horizons through the prism of specific agro-chemical indicators, with emphasis on soil solution pH since it determines a differentiated bio-availability of the nutrients (BÜNEMANN et al. 1980). Humus content (H) is also of interest, as well as the total nitrogen content (Nt), the mobile phosphorus content, the available potassium content, secondary macro-elements (Ca, Mg, S), and micro-element content.
Soil is a very heterogeneous nutrition environment that supplies water and nutrients to the plants in different ways, depending on the reference levels (ATKINSON et WHITE 1980).
Soil agro-chemical parameters that characterise fertility state on apple-tree plantations are (DAVIDESCU & VELICICA DAVIDESCU, 1992): $pH_{aqueous\ extract}$ = 5.5-7.0, V > 60%, H = 3-4, IN = 2-3, P_{AL} = 60-80 ppm, K_{AL} = 200-300 ppm. Other micro-elements are also important

for apple-tree nutrition, with mobility and bio-availability depending largely on the pH, (ROBINSON, 1980)
Mineral requirements in normally-fed apple-trees are determined by genetic, soil and climate, and technological factors. HAVLIN *et al.* (2005) mention as critical values of nutrition in apple-trees the following concentrations of nutrients in the plant (shoot): N 1.9-2.3%, P 0.1-0.4%, K 1.2-1.8%, Ca 0.8-1.6%, Mg 0.25-0.45%, S 0.2-0.4%, Fe 50-200 ppm, B 30-50 ppm, Cu 6-12ppm, Zn 20-50 ppm, and Mn 25-135 ppm.
Upon fertilisation, we need to take into account the specificity of the nutrients in the fertilisers. Low-mobility elements (P, K) shall be applied on the soil earlier than the maximum requirements of the plants, and the supplements during vegetation shall be supplied through phase fertilisation during the periods with higher nutrition requirements.

MATERIAL AND METHOD

The studies and research carried out aimed at assessing soil as a nutrition environment depending on the nutrition requirements of the apple-trees.
We observed the methodology of sampling over the horizons 0-20 and 20-40 to assess differently the edaphic volume making up the nutrition environment of apple-trees.
The studied agro-chemical parameters of importance in the nutrition process in apple-trees were as follows: *p*H, H, N_{total}, P_{mobile}, $K_{available}$, with measurements made through current laboratory methods (colorimetry, atomic absorption spectrophoto-metry).
The study of the soil and of the soil – plant relationship on a fruit-tree plantation is a good opportunity to assess the nutrition balance of the nutrition environment depending on the plant requirements per phenol-phases of vegetation and nutrition periods in order to develop proper fertilisation systems.
The biological material is the apple varieties: *Florina*, *Prima* and *Generos*. Rootstock is M27, the small force. Plantation is 13-14 years old.
The research site was within the Didactic Station in Timisoara, at the Fruit-tree and Grapevine Centre, on the apple-tree orchard, in full Banat Plain landscape. Research period was 2009-2010.

RESULTS AND DISCUSSION

Soil has certain features as a nutrition environment for fruit-tree plantations, in general, and for apple-trees, in particular. Taking into account the features of the root system in apple-trees, we differentiated 2 levels (horizons) of water and nutrient supply, i.e. over 0-20 and 20-40 cm. For this reason, we measured agro-chemical indices and we determined soil features at two levels, as shown in *Table 1 and in Figures 1, 2, and 3.*
Apple-tree has nutrition requirements ranging between 2.3-3 kg N/t, 0.65-0.7 kg P2O5/t, 3-3.3 kg K2O/t, 0.25 kg CaO/t, and 0.17 kg MgO/t. There are also microelements playing an important role in the development and quality of yield, sugar synthesis, vitamins, etc.
Taking into account the normative limits concerning the necessary nutrients in apple-trees and the soil supply on fruit-tree plantations, we can assess the soil fertility level, the yield prognosis, and the fertilisation requirements.
If we take into account the level of the studied soil agro-chemical indices and the average reference values suggested by Davidescu & Velicica Davidescu (1992) – pHaqueous extract = 5.5-7.0, V > 60%, H = 3-4, IN = 2-3, PAL = 60-80 ppm, KAL = 200-300 ppm –

we can say that the reaction of the nutrition environment has optimal values of the nutrient bio-availability. Humus content is lower, i.e. about 40% of the reference one, phosphorus content is about 45.7%, and potassium content is about 65-70%.

Table 1.Soil agro-chemical parameters on the apple-tree plantation of the Didactic Station in Timişoara

	Depth (cm)	Agro-chemical parameters				
		*p*H	Humus (%)	Nt (%)	P_{mobile} (ppm)	$K_{available}$ (ppm)
	0-20	**6.90**	**1.95**	**1.16**	**32.55**	**172.00**
	20-40	**6.39**	**1.73**	**1.13**	**29.40**	**161.50**

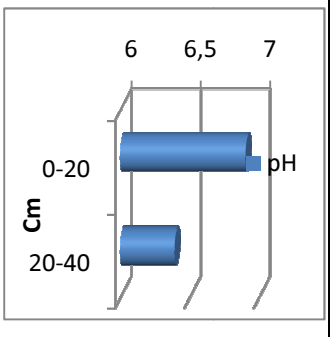

Fig. 1. Soil reaction as a nutrition environment for the apple-tree plantation

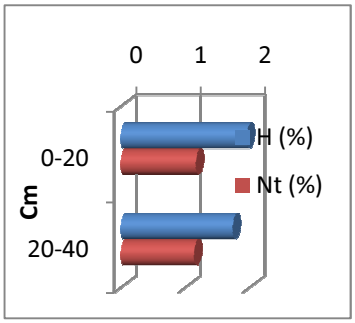

Fig. 2. Humus and total nitrogen contents (%)

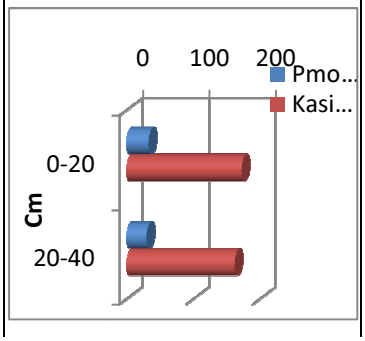

Fig. 3. Mobile phosphorus and available potassium (ppm)

Therefore, to ensure the necessary nutrients on the apple-tree plantation under the given experimental conditions, we need to supplement nutrients through fertilisation.
In apple-trees, there are 3 different periods of consumption: the critical period of consumption, during the budding-blooming phase; the maximum consumption period, during the fruit development and growth phases; and the low consumption period, during the fruit and shoot maturation phase (*Figure 4.*).

	Critical period of consumption	Maximum consumption period	Low consumption period
Vegetation phases and nutrition requirements in apple-tree	Budding and blooming	Fruit development and growth	Fruit and shoot development
			

Fig. 4. Nutrition requirements in apple-trees.

Taking into account these biological features and the specific consumption in the configuration of the yield, the fertilisation system should be adapted to ensure the necessary nutrients for the plants.
Knowing the nutrient requirements specific to an apple-tree plantation correlated to the vegetation and consumption periods allows the proper guidance of plant nutrition through the development of differentiated fertilisation systems in strict correlation with soil and climate conditions, with estimated yield, with type of fertiliser, and with application methods.
Applying fertilisers depending on sequential requirements (physiological and technological) on the fruit-tree plantation ensures a more efficient economically use of fertilisers, a diminution of pollution risks, and the development of a sustainable fruit-tree plantation.
Given the supply of soil minerals and nutritional requirements of the apple, established the plantation system of fertilization.
Complex mineral fertilizers ensure the necessary macronutrients (N, P, K, S) and is administered in the fall and spring. Foliar fertilizers (Fertifol 4-8 l/ha, Bionex 4-5 l/ha, Basfoliar 36 Extra 6-12 l/ha) provide the necessary micronutrients, and apply to vegetation.

CONCLUSIONS

On the fruit-tree plantation, the edaphic volume useful in an apple-tree is represented by 40 cm of soil, where heterogeneity is high, and soil reaction and nutrient bio-availability are variable.
Soil reaction is low in acids over the horizon 20-40 cm (pH = 6.39) and neuter over the horizon 0-20 cm (pH = 6.90), which leads to calcium phosphate development and to low soil phosphorus bio-availability. Average phosphorus content is 28.55 ppm P / 0-20 cm and 23.41 ppm P / 20-40 cm, respectively. Nitrogen and potassium are well represented quantitatively, while potassium is not threatened by temporal retention that diminished bio-availability.
Nutrient requirements in apple-trees are ensured through a system of fertilization correlated with the level of soil supply, with vegetation phases, and with specific consumption to ensure nutrient bio-availability.

ACKNOWLEDGEMENTS

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

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