

## EVOLUTION OF THE REACTION FOR THE TYPICAL PRELUVO SOIL THROUGH DIFFERENTIATED FERTILIZATION FOR APPLE CULTIVATION IN THE REGHIN AREA

Marilena MĂRGHITAȘ<sup>1</sup>, Constantin TOADER<sup>1</sup>, Mihaela MIHAI<sup>1</sup>, Lavinia MOLDOVAN<sup>1</sup>,  
Maria Hangan<sup>1</sup>

E-mail: [mmarghitas@usamvcluj.ro](mailto:mmarghitas@usamvcluj.ro)

### Abstract

The ecologic diversity of our country, as well as a shift in the forms of property in the last period have led to confusion and tremendous technologic inabilities and implicitly to obtaining agricultural and horticultural productions under the soil's biologic potential, as well as their production capacity, a situation inconceivable 22 years after the change in agricultural systems. The aim of the research resides in the study of the effect of a differentiated fertilization system, in the fruit-tree basin of Reghin, on the agrochemical evolution of the reaction of the typical preluvo soil cultivated with apple towards the optimum economic measures to be undertaken for fertilization, ecologic protection and an increase of both a quantitative and qualitative nature of fruit production, as well as maintaining it to the optimum parameters of the soil reaction and agriecosystem balance. The research relies on rigorous experiments on a typical preluvo soil in the Reghin area, with differentiated fertilization systems employing complex mineral, organic and organomineral fertilization, applied to the soil and foliarly for the *Golden Delicious* and *Starkrimson* apple varieties, widely spread in the area and on high consumer demand. In this context, the paper aims at approaching an area that nature and man have endowed with priceless gifts, that can only be referred to in the superlative. Despite the country's policy of destruction following the Revolution that was perceivable in all sectors of economy, including agriculture, farmers in the fruit tree basin of Reghin have risked enormously and fought by all means to save their fruit farms and keep this acknowledged fruit treebasin from being destroyed. The research materials and methods employed are those in agrochemical methodology and specific to the crop technology of apple cultivated on fruit-tree plantations. The importance, originality and degree of novelty of these agrochemical experiments are due to yet unsolved issues with regard to fertilizing combinations, by implementing a differentiated complex mineral fertilization system, both organic and organo-mineral, applied to the soil and foliarly to the *Golden Delicious* and *Starkrimson* varieties, in order to maintain and enhance the organic matter content in the soil and forming humus according to the climate specificity of the Reghin area and the specific and global consumption requirements of the apple varieties in the area. This fertilization system accompanied by a rigorous agrochemical control must provide a diversity of practical solutions in achieving the agrochemical optimum soil-plant-fertilizer and prevent soil and agriecosystem degradation and obtaining productions that are qualitatively superior and have met the parameters for food safety and security.

**Key words:** soil, fertilization, agrochemical modifications, apple

The cultivated apple adapted to the temperate climate where it was formed is an interspecific hybrid that has naturally resulted from the spontaneous consecutive cross of several species. It is the fruit tree species that occupies the first species as world production. This is first due to the special part that apples play in human diet, fresh as well as processed. Fresh apples contain important amounts of sugars, organic acids, pectic substances, tannoids, proteins, vitamins, mineral salts etc. For the food industry, apples are a significant raw matter, as they are employed in jam preparation, fruit preserves, juice, dry fruit and alcoholic beverages. The existence of over 10.000 apple varieties worldwide, with different ripening periods, provides fresh fruit consumption

throughout the year and especially winter, when the possibilities for the human organism to supply itself with vitamins is rather reduced.

Statistic data regarding the spread of the apple worldwide and in our country proves that this fruit-tree species is the first species cultivated in temperate climate. The soil and climate of our country provide most favourable conditions for apple cultivation, towards superior apple productions that consumers highly appreciate.

The paper relies on rigorous experiments in a classical apple plantation, on a typical preluvo soil (brown argilloalluvial) in the Reghin area, that followed the effect of differentiated fertilization systems, mineral complex, organic and organo-mineral applied to the soil and foliarly in

<sup>1</sup> University of Agricultural Sciences and Veterinary Medicine, Faculty of Agriculture, Cluj-Napoca, Romania

the case of the *Golden Delicious* and *Starkrimson* apple varieties.

## MATERIAL AND METHOD

The experiments were conducted in conditions similar to those needed for apple production in the hilly region, throughout three experimental years on a typical preluvosoil (brown argilloiluvial) in the fruit-tree region of Reghin, namely the apple plantation of S.C. Heliantus (from the former IAS Reghin), at the eastern border of the Transylvania Plain, north-west of Reghin, along National Road Reghin to Nasaud, neighboring villages are Sântu, Lunca Tecii and Dedrad. The surface area, where the farm is located, is characterized by an overall great diversity of relief, including small plates at an altitude of 400-500 meters, deep valleys, extensive slope processes across the entire slope caused by surface erosion but especially landslides, some very prominent, others not so severe making up small platforms of irregular configuration.

To fight erosion and landslides, serious investments have been made before the Revolution, by setting up fruit plantations organized as farms, where agriculture is practiced correctly aiming at the production of great organic fruit both quantitatively and qualitatively that is required for export.

The experiment was conducted over a three year period (2008-2010) and was polifactorial, on a representative lot in the apple plantation, according to two factors and the random-block design, with three annual repetitions, with the following graduations:

Factor A: apple variety with graduations:

$a_1$  – *Golden Delicious*;

$a_2$  – *Starkrimson*;

Factor B: level of fertilization with graduations:

$b_1$  –  $0N + 0P_2O_5 + 0K_2O$  (kg s.a./ha) + 0 t/ha stable manure (Unfertilized control);

$b_2$  –  $0N + 0P_2O_5 + 0K_2O$  (kg s.a./ha) + 20 t/ha stable manure, once a year;

$b_3$  –  $60N + 60P_2O_5 + 60K_2O$  (kg s.a./ha) + 20 t/ha stable manure, once a year;

$b_4$  –  $100N + 80P_2O_5 + 100K_2O$  (kg s.a./ha) + 40 t/ha stable manure, once every 3 years;

$b_5$  –  $100N + 80P_2O_5 + 100K_2O$  (kg s.a./ha) + 0 t/ha stable manure;

$b_6$  –  $120N + 100P_2O_5 + 120K_2O$  (kg s.a./ha) + 0 t/ha stable manure;

$b_7$  –  $60N + 60P_2O_5 + 60K_2O$  (kg s.a./ha) + foliar;

$b_8$  –  $100N + 80P_2O_5 + 100K_2O$  (kg s.a./ha) + foliar;

$b_9$  –  $120N + 100P_2O_5 + 120K_2O$  (kg s.a./ha) + foliar.

In the case of polifactorial experiments with two factors, the first with two graduations and second with nine graduations, resulted in a number of 18 variants (table 1). For each variant 5 trees

underwent the study according to 3 repetitions, resulting in 15 trees each year for a variant and repetition yearly. Fertilization levels established in the experiment were consistent with the purpose of research and pedo-agrochemical soil characteristics of the typical preluvosoil in the Reghin area, held by the owner of the orchard at the time of the research. The manure used in fertilizing the trees was household- produced as it was also a livestock farm, particularly for young cattle for meat and dairy cows. Mineral fertilizers were purchased by the owner, in that period, with grants from city hall and from farm earnings.

The fruit tree plantation under study is the classic type, of "lobed cross" crown in both apple varieties *Golden Delicious* and *Starkrimson*, grafted on rootstock 'M 11', where trees are planted at a distance of 7 m between rows and 6 m a row, resulting in 238 trees/ha. The type of crown chosen is well adapted to the lot, ensuring light penetration, thus aiming at an optimal development of trees, with a balanced distribution of structure capable of handling production of 300, up to 400 kg/tree in the case of a plantation reaching its full fruitition potential.

The varieties under study were those in the plantation and are most common both in the area and nationwide for their high production potential and tasty fruit in high consumer demand, fresh as well as processed.

To attain the objectives set, in autumn, respectively in October, organic fertilizers were applied (in the autumn of 2008, every three years) alongside chemical fertilizers with phosphorus and potassium (applied each autumn), according to the doses provided in the experimental variants.

Soil fertilizer incorporation was performed during the autumn plowing at a depth of 20-25 cm with plow type PP 2-30 in aggregate with 445 U DT. Plots were fertilized with a nitrogen fertilizer performed in spring, namely in March, using ammonium nitrate, for production during each experimental year, according to the doses provided in the experimental variants. Incorporation of chemical fertilizers with nitrogen, was conducted immediately following application, by disking with tractor type U 445 DT and harrow aggregate GDP 2.5 at a 15-18 cm depth.

Foliar fertilizers were applied simultaneously with phytosanitary treatments during the growing season and the phenophases that exhibited the main nutrient consumption for conventional apple during their full ripening period, the two applications. The practical tree cutting work was performed during the dormant period, each year. Maintenance during the growing season, aimed at fighting weeds, soil aeration and at the control of pests and diseases in order to maintain clean foliage trees, for the longest period of time possible.

Diseases and pest control was carried out in time, depending on the time of their occurrence by means of pesticides or fungicides either mixed with

insecticides, or by themselves, according to the degree of attack and crop year, beginning with March-April, up on or around July 20-25, when a final spray is regularly applied before harvest. This time span is absolutely necessary to achieve a required rest period of about 45-50 days from the last spray and up to the harvest, in order to eliminate the toxic effect of pesticides used on apple fruits. Apple fruit harvesting was performed manually, before consumption maturity, because their ripening completes after picking perfected, during transport and storage.

Determination of the production was done by weighing each variant, according to quality classes (Extra, Class I, Class II and Substas), making the alternative mean according to tree and variant, only to finally report apple production per unit area (hectare). To establish the necessary tree fertilizers to trees, agrochemical studies were conducted as follows:

Soil agrochemical analyses were performed according ICPA methodology for agrochemistry laboratories "Agrochemical analysis methodology

to assess the fertilizer and amendment requirement" ICPA 1981

The chemical analysis of the major mineral elements in plants was conducted according to the methodology ICPA laboratories agrochemistry "Plant analysis methodology to assess the mineral nutrition state", ICPA 1980.

## RESULTS AND DISCUSSIONS

The preluvo soil in the acknowledged fruit growing basin of Reghin under study during the experimental period is representative for this area and shows the essential traits of the argiloilluvial class, with weak acidic traits and lack of alkali saturation. Its reaction is at the border of moderate acidic to weak acidic with pH values ranging from 5.01 to 5.85, the two sampling depths of soil where most roots of fruit trees expand (*table 1*).

Table 1

**The pH evolution of the typical preluvo soil (brown argiloilluvial) through differentiated fertilization in *Golden Delicious* and *Starkrimson* varieties, in the fruit tree basin of Reghin (Experimental years: 2008-2010)**

Fertilization variant	Agrochemical evolution of the pH on a typical preluvo soil under <i>Golden Delicious</i> cultivation						Agrochemical evolution of the pH on a typical preluvo soil under <i>Starkrimson</i> cultivation					
	2008		2009		2010		2008		2009		2010	
	pH H <sub>2</sub> O	pH H <sub>2</sub> O	pH H <sub>2</sub> O	pH H <sub>2</sub> O	pH H <sub>2</sub> O	pH H <sub>2</sub> O	pH H <sub>2</sub> O	pH H <sub>2</sub> O	pH H <sub>2</sub> O	pH H <sub>2</sub> O	pH H <sub>2</sub> O	pH H <sub>2</sub> O
	0-20 cm	20-40cm	0-20 cm	20-40cm	0-20 cm	20-40cm	0-20 cm	20-40cm	0-20 cm	20-40cm	0-20 cm	20-40 cm
V <sub>1</sub>	5.49	5.60	5.50	5.61	5.50	5.62	5.27	5.60	5.28	5.61	5.29	5.61
V <sub>2</sub>	5.35	5.50	5.37	5.51	5.39	5.56	5.11	5.01	5.12	5.03	5.15	5.05
V <sub>3</sub>	5.27	4.94	5.28	4.95	5.30	4.99	5.01	4.80	5.03	4.82	5.05	4.85
V <sub>4</sub>	5.07	5.26	5.09	5.28	5.10	5.30	5.39	5.54	5.40	5.57	5.44	5.60
V <sub>5</sub>	5.11	4.85	5.11	4.85	5.11	4.88	5.34	5.65	5.35	5.66	5.36	5.67
V <sub>6</sub>	5.28	5.11	5.28	5.11	5.29	5.14	5.52	5.54	5.54	5.55	5.56	5.56
V <sub>7</sub>	5.53	5.27	5.54	5.28	5.55	5.30	5.44	5.45	5.46	5.46	5.48	5.46
V <sub>8</sub>	5.51	5.52	5.52	5.54	5.54	5.56	5.30	5.45	5.30	5.45	5.31	5.47
V <sub>9</sub>	5.52	5.59	5.53	5.61	5.55	5.64	5.47	5.26	5.48	5.27	5.49	5.28

Changes of the state of reaction due to differentiated fertilization in apple, reveals the striking protective and ecological character of the classic application of manure, every three years, within organic fertilizing variants and organo-mineral ones, due to the humifiable organic matter supply resulted from a significant raw plant material accumulation in the soil superficial horizon. The organic support provided by the application of organic manure in doses of 20 - 40 t/ha shows a favorable agrochemical and meliorating environment for the soil's physical and

chemical properties, while the additional application of mineral fertilizers causes a greater bioavailability of nutrients and a better capitalization by fruit trees, when soil moisture conditions are optimal. In foliar fertilized variants, constant pH values of 5.54 to 5.55 highlight the protective nature of foliar fertilizers for the soil reaction and maintain it at least at the initial level of fertilization.

One-sided fertilizations with complex mineral fertilizers (NPK), either in normal or increased doses causes a significant acidification of

the soil solution, due to a specific trait of the preluvosoil, as devoid of alkali saturation. These exclusively mineral fertilization of preluvosoils on fruit farms determines the acidification phenomenon, and therefore, it is absolutely necessary to take measures to implement mineral assortments more able to protect reaction minerals, as well as attracting organic nutrients that can prevent soil degradation through acidification.

## CONCLUSIONS AND RECOMMENDATIONS

The typical preluvosoil (argillic brown), typical to the fruit growing basin Reghin is clearly favorable for tree plantations by applying differing systems of organo-mineral fertilization with an organic substrate provided every three years, essentially changing the soil reaction, upon exclusively mineral fertilization.

Organic fertilization applied periodically, on the fruit trees cultivated in the area positively changes soil reaction on the long term, when you may encounter, by neutralizing it, the alkalization of the adsorptive complex of the soil and thus to improve its physicochemical characteristics.

Organo-mineral fertilization, consistent with the biological and nutritional requirements of the apple fruit, increases the bioavailability of the nutrients in the soil, with organic contribution exhibiting a direct or residual effect in the years immediately following application, improving the soil's undesired reaction, maintains and enhances soil fertility in fruit-tree plantations.

It is increasingly recommended for soils with limited fertility levels and for their productive capacity, to use manure as basic fertilizer. As such, rational use of crop residues and livestock waste all

contribute to increasing the content of organic matter in soils and the nutrient supply for plants, supplemented by mineral fertilizers where specific consumer requirements and overall fruit species grown, require it.

Foliar fertilization alongside its complementary role as plant nutrients protects soil reaction and maintain it at optimal values in compliance with fruit tree requirements.

Agrochemical results presented lead to recommendations for dissemination in the field of agriculture, promoting the organo-mineral fertilizer systems and complex mineral and foliar one, protecting soil fertility and effective for apple cultivation in the area. To the same extent, for other crops, recommendations can be made to improve the soil reaction, combined with specific fertilization procedures in the areato aim atreal protection for agrieocosystems of the Reghin basin.

## REFERENCES

- Bordeianu, T., Dumitrache, I., 1968**, *Influence of stable manure and foliar fertilizers on fruit tree growth and frutition*, in *Romanian*, ICPP Pitești, vol. I:225-233;
- Hangan Maria, 2011**, *Research on the agrochemical evolution of the typical preluvosoil and argic chernozem through differentiated fertilization for apple-tree growing in the Reghin area*, PhD Thesis;
- Mărghitaș Marilena, M. Rusu, Tania Mihăiescu, 2005**, *Fertilization of agricultural and horticultural plants*, AcademicPres, Cluj-Napoca;
- Mărghitaș Marilena et al., 2011**, *Good practice manual for the fertilization technology for agricultural plants*, AcademicPres, Cluj-Napoca.
- Rusu Mihai, Marilena Mărghitaș, Constantin Toader, Mihaela Mihai, 2010**, *Agrochemical mapping-agrochemical soil study*, AcademicPres, Cluj-Napoca;