SUMMARY

Keywords: fertilizers, macroelements, soil, leaves, fruit quality

Apple culture is the most common one in temperate climate areas. From this viewpoint, apples are ranked first in the volume of production, qualitative-food value and their demand on the market. The high ecological plasticity of this species afforded a wide geographical distribution of the many varieties.

In the modern sense, soil fertility is given by a complex of agro-eco-pedological factors in which the soil chemist plays a major role in defining it. The state of soil assurance with nutrients in assimilating forms, as well as an entire complex of factors and processes that influence soil such as pH, redox potential, collision capacity, absorption capacity, and anchor and retention capacity are incontestable agrochemical landmarks of the fertility state.

Knowing the value of agrochemical soil parameters that characterize the state of soil fertility is extremely important in appreciating the opportunity and quantitative level of some agrochemical measures for amendment and fertilization, but also allows their long-term control to prevent side effects in the growth and development of fruit trees.

In this context, the present work proposes a study of apple fertilization, using radicular and foliar fertilizers in a specific area, that of Copou-Iași. Both the experiments conducted in the field and laboratory research aimed at meeting a major objective of the conducted study, namely the impact of mineral fertilization of Idared variety on the quantitative and qualitative apple production by preserving and potentiating soil fertility state in a well established agro-eco-pedological context.

The work is divided into two parts.

Part I is entitled " Current state of knowledge" and comprises two chapters.

The first chapter comprises information on food and economic importance of apple cultivation, the evolution of apple orchards surfaces in our country and worldwide and the main countries on the market.

The second chapter presents results and conclusions on the stability of the fertilizing system in apple orchards at a national and international level. The literature of the field shows

aspects of agrochemical indices that limit apple culture and the influence of orographic and pedological factors on the state of fruit tree content of nutrients. A corresponding nutrition causes a discomfort at the level of fruit trees which is shown in reduced vegetative growth, the occurrence of symptoms that indicate flaws and the decrease of apple production. The application of various doses and fertilizer varieties, as well as their method of administration influences soil fertility, the content of nutrients in leaves and the quantitative and qualitative production of fruit.

The second part of the doctoral thesis discusses the "Results Obtained and Their Interpretation" and comprises five chapters.

The third chapter renders in detail aspects on experiment organization and the objectives followed during the three experimental years, 2010-2012:

- Evolution of the state of soil fertility after
- Emphasis of the fertilization influence on the plants' level of mineral nutrition;
- Influence fertilization on the quality and quantity of apple production.

The biological material considered in this study is the apple variety Idared which is one of the most significant varieties at the national level, being cultivated in most areas destined for tree plantations. The type of fertilizer used within fertilization variants is a complex solid fertilizer radicular application and two liquid complex fertilizers with foliar application.

In the experimental device, experimental factors graduation was as follows:

Factor A: fertilizer type

a_1 – NPK - 15:15:15 → complex solid fertilizer radicular application

a_2 – Pentakeep → liquid complex fertilizers with foliar application

a_3 – Cropmax → liquid complex fertilizers with foliar application

Factorul B – complex solid fertilizer dose

b_o – unfertilized

b_1 – $N_{60}P_{60}K_{60,}$ 180 kg/ha s.a.

b_2 – $N_{90}P_{90}K_{90,}$ 270 kg/ha s.a.

The methodology for determining nutrients in soil and plants and the pedological study was carried out according to the ongoing regulations issued by the Romanian Standards Association (ASRO). The results obtained were subjected to analysis and statistical interpretation to highlight the fertilizers degree of influence on the data obtained during our investigations.

Copou - Iasi ecosystem is described in chapter IV which presents the eco-pedo-climatic conditions of the "V. Adamachi" didactic pharm: geographical location, geomorphology, hydrology, climatic conditions and pedological aspect.

Given the average year temperature and the amount of annual precipitation, apple culture has favourable conditions to grow and develop in this area.

Chapter V comprises research on the evolution of the total forms of soil and plant nutrients, the fruit production obtained as a result of fertilization and the influence of fertilization on maturation indices and apple quality.

For 0-20 cm deep radicular fertilization and for radicular and foliar fertilization, combined total nitrogen accumulation in the soil for the three experimental years was proved to have clear and relatively stable influences on this indicator. The values of total nitrogen content progressively increase with the applied doses from the $N_{60}P_{60}K_{60}$ variant with 0.345 % Nt to the $N_{90}P_{90}K_{90}$ +Cropmax that records 0.391 % Nt, as compared to 20-40 cm depth in which the values of total nitrogen content are naturally low between 0.257 % Nt in the $N_{90}P_{90}K_{90}$ variant and 0.297 % Nt in the $N_{90}P_{90}K_{90}$ + Cropmax variant.

By analyzing the content and forms of mobile phosphorus in the soil for the two depths as control variant and exclusively foliar fertilized variants, Pentakeep and Cropmax, respectively, we noted a gradual decrease of phosphate fertility from 2010 to 2012, which was justified by the lack of solid fertilizers with radicular administration to enrich the phosphate heritage of the soil. The 20-40 cm soil depth, root fertilization variant $N_{90}P_{90}K_{90}$ reach maximum insurance with available phosphorus, 67,02 ppm respectively P-AL, value very significantly positive.

The content of potassium forms in the soil not only through the determination of total, unchangeable soluble and hydrosoluble, but also of the seasonal states of these potassium forms support the differentiation of the fertilizer doses which need to be applied. The fertilizer doses with radicular and radicular + foliar administration led to concentrations over 250 ppm K-AL for 0-20 cm soil depth, values recorded as being high; for 20-40 cm soil depth, all fertilizer variants are below 200 ppm K-AL including soil in the normal supply with this nutrient.

Quantitative analyses on fruit nutrients accumulation for the considered species are correlated with other factors that influence growth and development such as climate factors, state of soil fertility, applied agrotechnics, culture phytosanitary state and the possible treatments

carried out for the maintenance of the state of health. In this way, correct interpretation of the data and the application of appropriate measures are possible.

Further to the application of fertilization, the total nitrogen content in vegetal material was included in the state of the optimal tree assurance with this element for all fertilization variants and went beyond 2% Nt dry matter. Rises were recorded in relation to the control variant; they were caused by the contribution of this element to radicular, foliar fertilization and radicular fertilization with foliar fertilizers.

The rhythm of absorption and the accumulation of total phosphorus forms in the plant is specific to the phenophases investigated and different in relation to fertilizing variants. For all variants, phosphate nutrition can be distinguished. This exceeds the control variant with tendencies for a high supply of the trees with this element. In the experiment year 2012, due to high temperatures and low precipitation in the vegetation period, a greater difference between radicular and foliar fertilization occurred.

Analyzing the average of content results for total potassium in plants for the three experimental years, we notice the clear difference in the relation of radicular – foliar fertilization. Radicular fertilization completed with foliar fertilization brings the value of potassium concentration to the optimal interval in providing the trees with this nutrient. We note the radical fertilizing variants combined with Pentakeep, the potassium concentration in this nutrient being of 3% in K_2O. The values included in the optimal state of potassium provision are obtained in radicular fertilization variants completed with Pentakeep, 1,35 % and 1,26 % Kt dry matter.

Even if soils are rich in calcium which is accessible to plants, its distribution in the plant organs is unequal, hence the high concentrations at foliar level, yet increased in fruit level, causing physiological degradations. The content in calcium is determined in leaves and can be situated at a normal to high supply level, exceeding Ca by 1.25% in dry matter, for most of the fertilization variants.

Magnesium is essential in processes that are carried out at plant level, taking part in the accumulation and transport of glucides in plant. Pentakeep fertilization has a positive influence on the accumulation of magnesium at foliar level, 0,83 % Mg dry matter.

The accumulation of manganese at leaf level, on fertilization variants, behaves differently from an experimental year to another. The values obtained further to the chemical

analysis of vegetal material during the three experimental years can be assessed to a high supply state of the trees with this element, range from 66,54 to 85,12 ppm Mn in dry matter.

In the literature of the field, studies were conducted on the negative influence of insufficient zinc provision at plant level on vegetative growth, productivity and fruit quality. During the three experimental years, higher accumulations in radicular fertilization completed with foliar fertilization with Pentakeep were recorded: 14,96 ppm ($N_{90}P_{90}K_{90}$ + Pentakeep), 14,56 ppm (Pentakeep), 14,55 ppm Zn ($N_{60}P_{60}K_{60}$+ Pentakeep), due to zinc content into the Pentakeep, 0,07 % Zn.

The quantitative productions in the Idared apple variety, as in all species of plants cultivated are strongly influenced by the application of a complex, especially the one of three essential macroelements, nitrogen, phosphorus and potassium. The richest crops were obtained in radicular fertilization completed by Pentakeep. The average production obtained for the three experimental years is comprised between 24.75 t/ha and 30.21 t/ha. The highest yields were obtained from radicular fertilization completed with Pentakeep.

Amidine hydrolysis is defined through the splitting of polyglucoside amidine chains in simple sugars under the influence of the water. Thus the effect of quantitative diminution in amidine occurs, along with the increase in the content of soluble dry substance. The apples destined for storage need to have an amidine content of 40-60%, present in the transversal section of apple fruits in amidine test, the content that corresponds to 5-7 marks. In this context it is noted that Cropmax speeds up fruits ripening.

The more mature a fruit, the higher the hydrolysis of pectic substances, hence their diminished firmness. Along with fertilization, fruit firmness is also influenced by climatic conditions, the moment of apple harvest, dry substance content, amidine hydrolysis degree, etc. determining the variation of this indicator during the experimental years. Correlating the impact factors is found that apple yield with best firmness was the one harvested from the $N_{60}P_{60}K_{60}$ and Cropmax variants.

Production quality, through its indicators, dry matter, soluble solids content and titrable acidity, is influenced by both root and foliar fertilizer intake manage.

The clear influence of fertilization on total dry substance content can be noted, its increase being in direct ratio with the contribution of nutrients by fertilizer application. The

content of dry substance determined at the moment of apple harvest is normal, i.e. from 11-17% SUT.

Adjacent to the experimental factor, fertilizer application and variation in soluble dry substance content in apples for the three experimental years is determined by climatic conditions of the area and the moment of fruit harvest. Soluble dry substance content in apples for the three experimental years varied between 10.67% and 13.30%.

Highest potassium concentrations in fruit determine the increase in fruit acidity, hence the change of sugar/ organic acids and the change in their taste in the sense of taste enhancing. Higher fruit acidity was recorded in fertilization variants with a high contribution of potassium 0,439 mg malic acid/100 g ($N_{60}P_{60}K_{60}$+ Pentakeep) and 0,459 mg malic acid/100 g ($N_{90}P_{90}K_{90}$ + Pentakeep).

Chapter VI tackles aspects of economic efficiency in the use of fertilizers with radicular, foliar and combined application. It was recorded that the higher the fertilizer doses with radicular application combined with foliar fertilizers, the higher the expenses per surface unit and apple production. However the most effective variant in terms of income is $N_{90}P_{90}K_{90}$ + Pentakeep who achieve the highest production of 30,21 t / ha (2010-2012 average).

In the last chapter we present the conclusion reached on the influence of differentiated fertilization with an impact on soil fertility, of the supply state with nutrients in trees and the quantitative and qualitative apple production. The results obtained during the three years of investigations are mainly applicative on the choice of the fertilizer type in view of production output.