DIAGNOSTICS OF PARAMETERS OF INTERRELATION OF MINERAL NUTRITION AND FORMATION OF YIELD OF FRUIT CROPS FOR INTENSIVE TECHNOLOGIES OF THEIR CULTIVATION

T. MALYUK[1]; N. PCHOLKINA[1]; I. PACHEV[2]

[1]*Melitopol Research Fruit Growing Station named after M.F. Sidorenko of the Institute of Horticulture of National Academy of Agrarian Sciences of UKRAINE, 99 Vakulenchuk St., Melitipol, Zaporozhe region, Ukraine, 72311, e–mail: iosuaan@zp.ukrtel.net*
[2]*Institute of Viticulture and Enology–Pleven, BULGARIA*

Abstract. Results of research on definition of optimum level of providing nutrition elements for pome crops by identification of functional links between their contents in the soil, leaves and yield of plants in the south of Ukraine are given.

Key words: plant diagnostics, optimum content of elements, yield, intensive orchards of apple and pear.

Introduction

Agronomical aspect of every agro measure's effectiveness, including chemical measures, is based mainly on change of crops productivity.

So, directed regulation of plants nutrition by bringing mineral fertilizers in is the condition of getting genetically possible yield level [SERGEEVA *et al.*, 2008].

To solve the problem of rational fertilization of fruit crops, it is necessary to determine the amount of available for plants nutrients, and needed to form a biomass. Also, special attention is needed to find out the connection between amount of nutrients in soil, chemical composition of plants, and productive process of fruit crops [KUZIN, 2005].

Absolute amount of nutrients in separate parts of a tree is controlled by many factors, even geographical placement and schemes of planting [SERGEEVA *et al.*, 2008; KOPYTKO, 2001; TSERLING, 1990].

It is necessary to solve the problem of nutrient consumption by trees, considering not only variety, but also conditions of cultivation, age, yield amount etc.

According to physiological principle for acquiring high level of metabolism in vegetative organs of the plants has to be certain level of nutrients, at which processes of chemo –and photosynthesis are optimal [TRUNOV, 2006].

It is considered that for evaluation of nutrition regime leaf is most suitable, results of its analysis are compared to optimal amount of certain element. However, different authors state optimal amounts differently.

Optimal amount of nitrogen in leaves of pome crops varies from 1,6÷2,0 % to 2,9÷4,6 %, potassium–from 0,9÷1,3 % to 1,2÷2,1% [KUZIN, 2005; KOPYTKO, 2001; TSERLING, 1990; DERYUGIN and KULYUKIN, 1988].

Amount of phosphorus varies a lot as well. Also, phosphorus concentration in leaves can stay optimal, despite its low amount in soil.

Goal of the research was to determine optimal amount of nutrients for apple and pear trees in intensive technologies of cultivation in the conditions of Southern Steppe of Ukraine via finding out functional connections between their concentration in the soil, leaves, and trees' yield as integrated feature of degree of trees reaction to certain conditions of soil nutrition.

Materials and methods

Research was done in 2004–2011 based on field experiments of studying influence of putting in $N_{30–120}P_{15–75}K_{20–60}$

on regime of soil nutrition, chemical composition of leaves and yield of intensive orchards of apple: varieties Florina and Idared (rootstock M9); pear: varieties Conference and Izyuminka Crimu (rootstock quince A).

Scheme of planting for apple–4x1 and 4x1.5 meters, for pear–5x3 meters.

Soil–southern chernozem (black soil) heavy loamy, stationary drip irrigation.

Determination of amount of mobile forms of NPK (nitrogen, phosphorus, potassium) was done according to standard methods [DSTU–4729, 2007; DSTU–4114, 2002].

Total amount of NPK in leaves was defined in dynamics with burning (accelerated method by Ginsburg, Scheglova) [RADOV, 1985].

Mathematical analysis was done with Microsoft Excel.

Results and discussion

Results of the research show that leaves of apple and pear have clear seasonal rhythm of change of NPK concentration that shows itself in decrease of nutrients during vegetation.

Independently from fertilization system, maximal amount of elements was in the beginning phases and was for apple 2.62–3.74 %, 0.28–0.37 % and 1.31–1.53 % of dry mass respectively for elements. Same tendency was observed for pear leaves.

During the vegetation their concentration decreased, and during the end of vegetative growth of trees, that is considered the best time for taking leaves for analysis, it was not higher than: nitrogen 1.44–2.46%, phosphorus 0.10–0.20%, potassium 0.44–1.00% of dry mass depending on the crop.

At the same time, valid but small influence of change of nutrition regime of soil due to fertilizers effect on amount of macroelements in leaves was observed.

For example, it was found out that using nitrogen fertilizers (separately or in NPK) validly increased amount of nitrogen in apple and pear leaves to 0.41–0.72%

(with smallest valid difference SVD_{05}=0.3 %).

However, this increase not always corresponded to nitrogen dose.

Medium correlation was determined between total amount of nitrogen in leaves and nitrogen dose in fertilizers r=0.58–0.67). Similar correlation was observed for potassium with r=0.53–0.61.

Use of phosphorus in most cases didn't significantly change its concentration in leaves. It was also determined that amount of nitrogen in leaves has significant connection to its amount in soil (r=0.72–0.87).

At the same time, phosphorus and potassium concentration in leaves in most cases didn't have significant connection to its amount in soil.

It was determined that amount of potassium in leaves during the end of vegetative growth was lower than average optimal amounts for apple and pear the earlier established for South of Ukraine.

Same tendency in some cases was for amount of nitrogen.

At same time, separate data was determined, that point out for excessive amount of total nitrogen in apple leaves even with no fertilization (control) and with moderate fertilizer doses.

So, results of plant analysis testify of lack of exceed of certain elements, despite optimal level of amounts of available for plants forms of nitrogen and potassium, and also no diagnostic signs of disturbance of mineral nutrition process.

Change of climate, introduction of intensive technologies with dense planting, use of clonal rootstocks, modern irrigation *etc.* are factors that influence changes of elementary chemical composition and amount of nutrients in vegetative organs of plants.

So, optimal levels of amounts of nutrients in plants, determined in previous years, in modern conditions are not always proper.

From point of view of determining real need of fruit crops for mineral nutrition, it is important to find out the range of amount of elements in which

optimal quality of nutrition and planned yield are received.

To achieve that, degree of connection between amount of NPK in leaves of pome crops and their yield as basic sign of influence of change of mineral nutrition on intensity of all physiological and biochemical processes in the plant. Analysis showed linear relation of yield of pear varieties Conference and Izyuminka Crimu and apple varieties Florina and Idared from amount of nitrogen in leaves with fertilization (table 1).

Table 1.

Results of regression analysis for relation between function of yield of apple and pear, centners/ha (y) and total amount of nitrogen and potassium in leaves (x)

Crop	Variety	Nitrogen Regression equation	R^2	Potassium Regression equation	R^2
Apple	Idared	У = 633.9–165.6 x	0,76	y = 543.4–497.6 x	0.78
	Florina	У = 771.7–265.0 x	0,80	y = 484.4–381.4 x	0.83
Pear	Conference	–	–	y = 253.3–187.4 x	0.80
	Izyuminka Crimu	У = 394.83–119.6 x	0,81	y = 289.2–164.6 x	0.84

For variety Conference there also is relation between these indexes ($r=-0.66$, $S_r = 0.08$).

However, its character is better described by polynomial of third order ($R^2=0.93$), and use of it is difficult because of complicated math and accordance of different amounts of nitrogen to same yield.

Valid relation between yield of trees and amount of potassium in leaves of apple and pear ($r=-0.88\pm0.08-0.92\pm0.06$) was determined and regression equation for this relation were solved. Amount of phosphorus had the lowest degree of connection to yield.

As one can see from picture, where graphic expressions of dependency of function of yield of apple variety Florina from indexes of total amount of nitrogen and potassium in leaves is shown as an example, yield not lower than 250, centners/ha (tons/ha) can be expected when amount of nitrogen in leaves is 1.7–2.2%, potassium–0.4–0.6%. Similar regularity was observed for apple variety Idared and pear varieties Conference and Izyuminka Crimu (Figure 1).
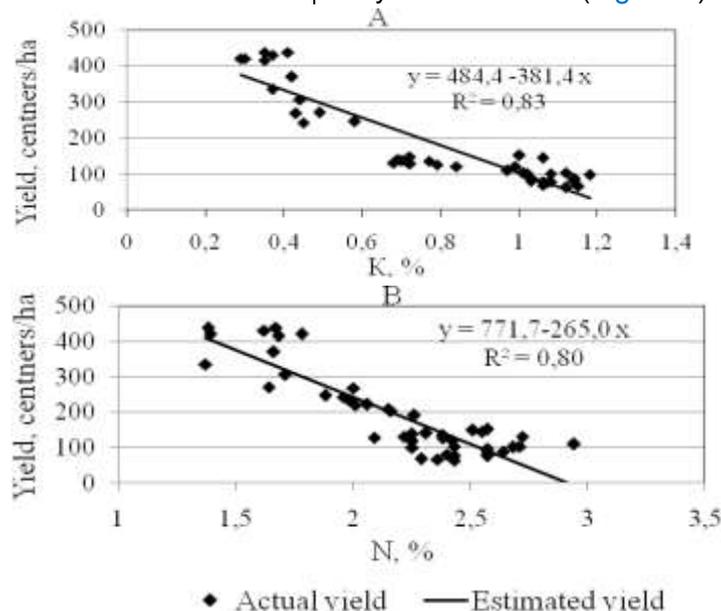

Figure 1. Relation between yield of apple variety Florina and amount of potassium (A) and nitrogen (B) in leaves

Considering that yield of fruit crops is summary index of many physiological and biochemical processes that happened in plant during different stages of onto–and phylogenesis, range of amount of nutrients, which allows high level of yield with high quality fruit, can be taken as optimal, during which processes of mineral nutrition for certain element are optimal.

So, to achieve best quality of nutrition of pome crops that are cultivated with intensive technologies on southern chernozem (black soil), it is needed to maintain nitrogen level in leaves of apple and pear in range of 1.7÷2.2 %, potassium – 0.4÷0.6 %.

Conclusions

Optimal range of indexes of amount of nitrogen and potassium in leaves of pome crops for intensive technologies of cultivation in condition of Southern Steppe of Ukraine, in which optimal quality of nutrition is maintained, and high yield of fruit is achieved, is 1.7÷2.2 % i 0.4÷0.6 %, respectively.

Use of standard figures of optimum of concentration of these elements for diagnostics and determination of fertilization doses can lead to lowering the effect of fertilizers, and increasing ecological load on soil as a result of excessive fertilization.

References

1. Deryugin, I.P.; Agrochemical basics of fruit and vegetable crops fertilization systems: [textbook and directory for students of universities]. In: Deryugin, I.P.; Kulyukin, A.N.; *M.: Agropromizdat*, **1988**. 270 pp.
2. DSTU 4114–2002; Soils. Determination of mobile compounds of phosphorus and potassium by modified Machigin method: DSTU 4114–2002. [Operating from 2003–01–01]. K.: The state committee of Ukraine concerning technical regulation and consumer policy, **2002**. 7 pp.
3. DSTU 4729:2007; Quality of the soil. Definition of nitrate and ammoniac nitrogen in NSC «Institute for Soil Science and Agrochemistry Research named after O.N. Sokolovsky» modification of O.N. Sokolovsky: DSTU 4729:2007. [Operating from 2008–01–01]. K.: Derzhspozhiv standart of Ukraine, **2008**. 10 pp.
4. Kopytko, P.G.; Fertilization of fruit and berry crops: tutorial. In: Kopytko, P.G.; *K.: Vischa schkola*, **2001**. 206 pp.
5. Kuzin, A.I.; To the question of leaf diagnostics of mineral nutrition of apple sapling on low–growth rootstocks. In: Kuzin, A.I.; *MichGAU Hearld. Michurinsk*, **2005**. *2*(1):117–121.
6. Radov, A.S.; Agrochemistry practicum: [textbook and directory for agricultural universities]. In: Radov, A.S.; Pustovoy, I.V.; Korolkov, A.V.; under edition of *I.V. Pustovoy. [fourth edition]. M.: Agropromizdat*, **1985**. 312 pp.
7. Sergeeva N.N. Creteria for evaluation of effectiveness of use of fertilization system in garden agrocenosis of intensive type. In: Sergeeva, N.N.; Zakharova, M.E.; Fedorkova, N.P.; Optimisation of technological and economical features of agrocenosis structure and regulations of fruit crops and grapes cultivation. *Krasnodar*, **2008**. *1*:253–257.
8. Trunov, Y.V.; Influence of foliar mineral nutrition on productivity and fruit quality of apple. In: Trunov, Y.V.; Greznev, O.A.; *MichGAU Hearld. Michurinsk*, **2006**. *2*(1):146–151.
9. Tserling, V.V.; Diagnostics of agricultural crops nutrition: directory. In: Tserling V.V.; *M.: Agropromizdat*, **1990**. 236 pp.