

RESEARCH ON OPTIMIZING MINERAL NUTRITION IN PEAR PLANTING

KOPYTKO P.H., Doctor of Agricultural Sciences, Professor
Yakovenko R.V., Candidate of Agricultural Sciences,
Petryshyna I.P., Graduate Student
Uman National University of Horticulture

The preliminary results of the research on optimizing mineral nutrition of pear planting by fertilization on the dark-grey podzolized soil of Right-Bank Forest-Steppe of Ukraine are considered.

Keywords: pears, optimization of mineral nutrition, fertilization, yielding capacity.

In the garden agro ecosystems conditions of mineral nutrition of fruit trees during the first years after planting are predetermined by bedding up the soil, and then by its maintenance systems in plantations and their fertilization. The most long-termed and diverse researches with fertilizing of apple plantations was held in Uman National University of Horticulture [1-8]. Based on the results of the researches correlations between changes in levels of soil mineral nutrition of plants depending on fertilizer (organic, mineral and organic-mineral), norms and ratios of mineral fertilizers and adequate response of fruit trees to these changes by weakening or strengthening of growth processes, increase or decrease in productivity plantations were found. In these and other studies [9-15] the effectiveness of certain types of fertilizer doses and their norms and relationships is largely dependent on environmental conditions (zonal soil, climate and weather, etc.), construction plants, their rootstock-sorted structure, systems of holding soil in them, and many other factors that affect the productivity of fruit plants.

Based on the results of the research on fertilizing apple by problem research laboratory of Uman National University of Horticulture on optimizing soil fertility on fruits and berries plantations, the optimum levels of nitrogen, phosphorus and potassium nutrition for strong trees on rootstock seed grown on different soil types in the steppe, the forest-steppe and Polissia zones are established [3]. Particularly for apples grown on a dark gray podzolized heavy loamy soil under the conditions of forest-steppe the optimum levels are: content of N-NO₃, which is determined by the ability of nitrification ability of soil in the layer 0 – 40 cm – 220 – 250 mg / kg; content of P₂O₅ and K₂O in the layer 0 – 60 cm by Ehner-Rim-Domingo method, respectively, is 70 – 100 and 230 – 280 mg / kg of soil. These levels should be used for determination (calculation) of fertilizer norms (NRK) and plantations of pear as a garden culture which is very close to the apple.

However, there are some differences between apples and pears in mineral nutrition depending on the growth of productivity at a young age and yield of fruit-

bearing period by growing different varieties of rootstock-graded combinations. According to the studies [4] 30-year-old apple and pear trees during the whole period of cultivation took out of the soil, respectively, nitrogen 385 and 274 kg/ha, phosphorus (P_2O_5) – 126 and 120, and potassium (K_2O) 470 and 394 kg/ha, including fruit harvest – 289 and 111, 104 and 78 and 397 and 270 kg/ha, and localized in the trees – 96 and 163, 22 and 42 and 76 and 124 kg /ha.

So, apple generally picked from the soil much more nitrogen and potassium than pear and almost the same amount of phosphorus, and for the formation of yield fruit it picked much more than all elements of nutrition, and pear assimilated more for the creation of vegetative biomass. Thus, obviously, it's not worth identifying the needs of apples and pears in mineral nutrients both during biomass growth at a young age and during fruiting. Furthermore, pear comparing with apple is less cold-resistant [3, 16, 17]. And despite the fact that the various elements of mineral nutrition do not have the same impact on growth and reproductive processes and in aging tissues of fruit trees and bodies and, therefore, the resistance to unfavorable external environment, such as low temperatures in winter, there is a need for research directly from the bag to clarify the provisions and recommendations for fertilization of plants in specific soil and climatic conditions, particularly in the Right-Bank Forest-Steppe. This is also necessary because only a few studies on pears and on its mineral nutrition and fertilization were conducted.

On the basis of the research results by T.V. Maliuk [18] about optimization of the nitrogen nutrition of new intensive pear plantations on the southern black soil was found that retail nitrogen application by doses N_{30} and N_{45} due to the phases of trees growth and development led to the greatest increase in yield such varieties as Konferentsiia and Iziurnynka Krymu, and with dose increasing to N_{60} and N_{90} further significant increment in yield was not observed. During many years of experiment at Melitopol plant gardening station the highest index of pears yield on sandy soil without irrigation was provided by applying a complete mineral fertilizer at a ratio of: nitrogen and potassium – 120 and phosphorus – 90 kg/ha. In this case increase of the yield reached to 30,6 kg/ha [9]. According to the research of A.S. Urdukhanov, A.T. Kardyshev, M.H. Adamov [19] the highest index of pears yield on chestnut loamy soil in Dagestan was by fertilization at doses $N_{60}P_{45}K_{60}$ – 50,4 – 109,5% more compared with the control option. I.I. Kryvoruchko [20] states that the highest increase in pears yield in new intensive orchards on alluvial soils in Krasnodar region was got by the application of mineral fertilizers in $N_{120}P_{60}K_{60}$ doses at the level of yields in the range of 100 – 150 dt/ha. For higher levels it needs to increase doses of NPK, for lower yield it should be decreased.

Methods of the research. In the experiment the effectiveness of optimized background of mineral nutrition compared with the absolute control – with no fertilizer and norms of fertilizer offered in zonal recommendations for production, and variations of their supplementary applying to the optimized background.

The experiment started in spring of 2010 to clarify optimization issue of mineral nutrition of pear using nitrogen, phosphorus and potassium in plantations on dark grey podzolized clay loamy soil had the purpose to study pear capacity under optimized cultivation on mineral nutrition backgrounds created by applying of

calculated fertilizer norms as for the apple-tree using the recommendations of problem research laboratory in Uman National University of Horticulture which works with the problems of optimizing soil fertility in fruits and berries plantations.

Experimental orchard with two pear varieties Konferentsiia and Osnovianska was planted in 2007. The scheme of the experiment includes six variations: 1. Without fertilizers (absolute control) 2. N90P60K90 (production control) 3. Calculated fertilizer norms (background) 4. Background + N30; 5. Background + N30K30; 6. Background + N30P30K30. Scheme has three repetitions with randomized block design where five registered trees on each plot are grown.

At the beginning of the experiment soil was provided with nitrate nitrogen (by nitrifiable ability) insufficiently (content of N – NO₃ in the layer of 0 – 40 cm was 16,5 mg/kg of soil), mobile phosphorus compounds with above sufficient level (P₂O₅ content by the method of Ehner-Rima-Domingo in the layer of 0 – 60 cm was 166 mg/kg of soil) and potassium (by the same method) was enough (K₂O content in the layer of 0 – 60 cm was 250 mg/kg of soil). Therefore, to create optimal background of nutrition with nitrogen, phosphorus and potassium in terms of agro-chemical analysis it was calculated the rate of nitrogen fertilizer only to bring the contents of N – NO₃ in the soil to the optimum level. Later soil in the experiment is analyzed annually and according to the results of the tests norms of fertilizers calculated for maintaining optimal background.

Results of the research. On average during 2011 – 2012 years with applying of nitrogen fertilizer norms calculated to bring the content of nitrate nitrogen to the optimum level, the content of N – NO₃ in the soil layer of 0 – 40 cm was within 21,2 – 24,6 mg/kg of soil. In the spring of 2012 calculated nitrogen norms based on the results of analysis on the plots of background variation were within 16,5 – 34,5 kg/ha, on the plots with supplementary applying of nitrogen in amount of 30 kg/ha to create a background level we used calculated norms of N 3,5 – 28.2 kg/ha, for background variation + N30K30 we used 2,3 – 21,9 kg/ha, and for background variation + N30P30K30 the amount was 34 – 39 kg/ha.

On the results of agrochemical analysis in 2012 it was revealed that the content of mobile compounds of potassium (K₂O after Ehner-Rima-Domingo method) in the layer of 0 – 60 cm was found in deficiency (it was below the optimal level). Therefore, to bring its contents to the optimal level in this layer of soil on fertilized areas we calculated and applied such amount of potash fertilizers: for background variation it was 230 – 260 kg/ha, for background + N30 it was 275 – 330; for background + N30K30 it was 115 – 320; background + N30P30K30 it was 200 – 330 kg/ha of K₂O.

In 2010 young trees began to bear fruits. We got yield in the amount of 3,7 – 4,9 t/ha from Konferentsiia variety on fertilized areas and from Osnovianska variety we got 1,9 – 2,9 t/ha, but on the plots without fertilizers yield values were 3,6 t/ha and 1,8 t/ha respectively. In 2011 yield of Konferentsiia variety in areas with applying fertilizers was 1,8 – 2,7 t/ha and Osnovianska variety was harvested 1,6 – 2,0 t/ha, but on the control plots (without fertilizers) it was 1,8 and 1,4 t/ha respectively. In 2012 yield value of Konferentsiia variety on fertilized areas was 7,9 – 8,8 t/ha and Osnovianska variety gave 2,3 – 3,1 t/ha which is significantly higher compared with

yield values on the plots without fertilizers that were 6,1 and 1,8 t/ha respectively.

Conclusions.

1. To optimize the nitrogen nutrition of pear fruit trees of varieties Konferentsiia and Osnovianska the accounting rates of nitrogen fertilizer, which provides the optimal level of nitrate nitrogen in soil (for its nitrification capacity), are needed significantly smaller than recommended for production in annual applying of N_{90} .

2. At higher level of mobile phosphates in soil on average the phosphate fertilizers are not applied nearly two times of the optimal level (166 mg / kg compared to 85 mg / kg), because nutrition of trees with phosphorus is enough and according to the existing recommendations phosphate fertilizers are applied annually within NRK 60 kg / ha.

3. At a low content of mobile compounds of potassium in soil compared to the minimum rate of optimal level (230 mg / kg) potash fertilizers are applied to provide optimum level of K_2O in the layer of 0 – 60 cm for the period of five years. These doses per year are much lower than recommended ones for the annual application of K_{90} .

4. Productivity of young trees of experimental varieties of pears in early fruiting in experimental versions with optimization of levels NPK in soil by fertilization on the third (2012) year significantly exceeded its indexes in control (no fertilizer applied), and the production control (in the annual apply of $N_{90}P_{60}K_{90}$) did not significantly differ.