Bulletin UASVM, Horticulture 65(1)/2008
pISSN 1843-5254; eISSN 1843-5394

# THE INFLUENCE OF MINERAL FERTILIZATION ABOUT NITROGEN CONTENT IN SOIL, PLANT AND TOMATO FRUIT

**Diana MOIGRADEAN[1], A. LAZUREANU[2], Mariana-Atena POIANA[1], Monica HARMANESCU[1], I. GOGOASA[1], I. GERGEN[1]**

[1] Banat′s University of Agricultural Sciences and Veterinary Medicine, Faculty of Food Processing Technology, 119 Calea Aradului Street, Timisoara, 300645, Romania
diamodean@yahoo.com
[2] Banat′s University of Agricultural Sciences and Veterinary Medicine, Faculty of Horticulture, 119 Calea Aradului Street, Timisoara, 300645, Romania

**Keywords:** nitrogen, soil, leaf, tomato

**Abstract:** Were investigated in this paper the nitrogen content in soil, in leaf and in tomato fruit after NPK fertilization. The experience was done in a cambic cernosium soil, with low acidity reaction and the high natural fertility potential favorable vegetables cultivation.
The study was performed on control soil samples (without fertilizers) and soil samples after differentiated NPK fertilization in variable dozes: $N_{30}P_{30}K_{30}$, $N_{45}P_{45}K_{45}$, $N_{60}P_{60}K_{60}$, $N_{120}P_{60}K_{60}$.
A field experiment was using tomatoes samples in different precocity steady: early (Export II) and middle tardy (Ace Royal).
Nitrate content in fruit varied from 0.27-0.45ppm; the highest concentration was found in $N_{45}P_{45}K_{45}$ doses fertilization and the lowest was in control. Tomatoes sorts did not influence the nitrogen content in fruit.
Nitrate content in soil before or at harvest are known to be critical factors in determining nitrate levels in tomato fruit.

## INTRODUCTION

Tomato is one of the popular and most consumed vegetable in the world.

Rate and type of nutrients applied in the form of fertilizers should be adjusted after analyzing the nutrient contents of soil and plant samples.

Nitrogen is one element are known as essential nutrients for plant growth (Brown, J.R., 2007).

Tomatoes are regularly fertilized with N, P, and K from liming to adjust soil pH. Optimum soil pH for tomatoes cultivation is between 6.0-6.5 (Manescu B., 2003).

Chemical fertilizer nitrogen is often in the ammonium nitrogen ($NH_4^+$) form and is rapidly converted to nitrate ($NO_3^-$) in the soil. The amount of crop growth is essentially the same whether nitrogen fertilizer is applied as ammonia ($NH_3$), ammonium or nitrate ($NO_3^-$). Chemical fertilizers may be composed of ammonium nitrate, ammonium phosphates, ammonium sulfate; various nitrate salts, urea and other organic forms of nitrogen. Soil organic matter contains about 5 percent N. Microorganisms must change organic nitrogen to ammonium or nitrate before plants can use it. Usual release of available N from soil organic matter is 1 to 4 percent annually, depending on soil texture and weather conditions. Annual additions of N to the soil through rain and snow about equal the amount leached. The soil serves as storehouse and supplier whether the essential nutrients are native or applied as fertilizers. A deficient supply of one or more essential element creates an imbalance in plant uptake and may cause abnormal growth. Excess nitrate within the plant may result from too little of some other plant nutrient rather than an excess of nitrogen. The nitrogen in soil that might eventually be used by plants has two sources-nitrogen-containing minerals and the vast storehouse of nitrogen in the atmosphere.

The nitrogen in soil minerals is released as the mineral decomposes. This process is generally quite slow and contributes only slightly to nitrogen nutrition on most soils. On soils containing large quantities of $NH_4$-rich clays (either naturally occurring or developed by fixation of $NH_4$ added as fertilizer), however, nitrogen supplied by the mineral fraction may be significant in some years (Brown, J.R., 2007).

Nitrate is a naturally occurring form of nitrogen and is an integral part of the nitrogen cycle in the environment. Nitrate is formed from fertilizers, decaying plants, manure and other organic residues. It is found in the air, soil, water and food (particularly in vegetables) and is produced naturally within the human body. Nitrate content differs in the various parts of a plant. Indeed, the vegetable organs can be listed by decreasing nitrate content as follows: petiole > leaf > stem > root > inflorescence > tuber > bulb > fruit > seed (Santamaria P., 1999).

Phosphorus, potassium and sulfur have major roles in production of proteins, thereby decreasing nitrate within the plant. (Brown, J.R., 2007) Phosphorus is absorbed as the $H_2PO_4$ - or $HPO_4$ = ion. This complex does not leach readily from the soil and is mobile once in the plant. Plants actually use relatively small amounts of P when compared to N and K. Excess phosphorus can induce nitrogen. Phosphorus is especially important for young plants and seedling growth. Potassium is absorbed as the ion $K^+$. Potassium is responsible for regulating the opening and closing of stomata by guard cells in the leaf. Potassium also is essential for translocating sugars and forming starch. Potassium encourages root growth and increases crop resistance to disease. Excess rain or irrigation can cause potassium to leach through the soil. Potassium is mobile once in the plant, meaning that deficiency symptoms will express in the old growth (Flynn, R., 2002).

Probably more than 90 percent of the nitrogen absorbed by plants is in the nitrate form (Brown, J. R., 2007).

While N deficiency in tomato can result from N removal by plant from the soil after the harvest of aboveground plant biomass, absence of soil amendaments, such as manures and fertilizers. As N applied from manures and fertilizers to the soil is readily converted into $NO_3$ for plant uptake, high rate of N fertilization can result in large amount of residual $NO_3$ build up in the soil after crop harvest. Because $NO_3$ is soluble in water, high concentration of residual $NO_3$ can increase the potential for N leaching from the soil and contaminate groundwater. The type of N fertilizer applied can also influence tomato production because $NH_4$-N can be toxic to tomato growth compared with $NO_3$-N (Sainju M.U., 2003). To obtain a best management practice that can sustain tomato yield, reduce the amount of N fertilization and N leaching, and improve soil quality and productivity (Sainju M.U., 1999).

Nitrogen is mobile in plants, which results in yellow lower leaves if there is a deficiency. Too much nitrogen in a plant results in succulent growth, very dark green color, weak spindly growth, and not much fruit. It also may cause brittle growth, especially under high temperatures. (Flynn, R., 2002) Tomatoes with vigorous foliage are usually low in nitrate content. However, where the plant is defoliated by disease, weather or other factors, the nitrate from the soil may move directly to the fruit and accumulate. (Brown, J.R., 2007) Nitrogen deficiency symptoms include reduced growth, yellowing of leaves (chlorosis), and reduced lateral breaks. Reds and purples also may intensify with some plants. Deficiency symptoms appear first in old growth. Corrective action for nitrogen deficiency includes fertilizing with a nitrate-based fertilizer. Soil test levels of nitrate should remain near 30 ppm during the active growing season (Flynn, R.,2002).

Under normal growing conditions with sufficient light as a source of energy, enzyme systems in green plants rapidly reduce nitrate-N ($NO_3^-$) to intermediate compounds that are subsequently converted into amino-nitrogen. Organic acids arise from carbohydrate metabolism in combination with the amino-nitrogen to yield amino acids in the plants. The amino acids are building blocks for proteins. This total process is dependent on sunlight. Nitrate reduction occurs both in aerial portions and roots of plants. The relative importance of these two sites of nitrate conversion is considered most important.

Young plants in the vegetative stage generally contain more nitrate than more mature plants of the same species (Brown, J. R., 2007).

The nitrogen also affects the ripening of the fruit; more fruits will be unevenly ripe at low nitrogen concentrations than at high (Grierson and Kader, 1986).

## MATERIALS AND METHODS

**Field experiments**

Sampling dept is the important factor for soil analyses. Deep sampling could pose a limitation for practical use in assessing N fertilization. Nitrate soil test are based on a 30 cm sampling dept. (Magdoff, F.R., 1984) Soil samples were taken (0-25 cm depth) before and after fertilization.

Was use dry/granulated fertilizers NPK – this is the most common type of fertilizer applied to the garden. Granules are coated to prevent moisture absorption. (Relf, D, 2002)

Fertilization was control (without fertilizers) and mineral fertilizers (NPK) in variable doses: $N_{30}P_{30}K_{30}$, $N_{45}P_{45}K_{45}$, $N_{60}P_{60}K_{60}$, $N_{120}P_{60}K_{60}$. Soil N supply with urea application.

**Analytical methods of samples**

Soil properties were analyzed using the fallowing methods: pH was determined in aqua solution. Total N [%] was determined by the Kjeldahl method, digested in $H_2SO_4$ distilled and titrated with 0.1M NaOH. Phosphorus was determined by spectrophotometry using Spectrophotometer UV-VIS SPECORD 205 by Analytik Jena and Potassium by flame photometry method. (MAIA, 1983) Nitrogen ($N-NO_3$) of tomatoes fruit was determined colorimetric in extract with acetic acid 2% by fenoldisulfonic acid method (MAIA, 1983).

Were used chemicals and reagents from Merck; deionized water.

The tomato wholes leaf was collected after first flower storey fructification.

Tomatoes samples were collected on June-July (varieties Export II) and August (Ace Royal).

## RESULTS AND DISCUSSIONS

In table 1 was presented soil agrochemical parameters before experiment.

Table 1

Soil agrochemical parameters before experiment

| pH | Humus [%] | $N_t$ [%] | P [ppm] | K [ppm] |
|---|---|---|---|---|
| 6.34 | 3.00 | 0.29 | 163 | 160 |

The soil analysis show that soil its favorable for tomatoes cultivation, with high natural fertility potential favorable vegetables cultivation.

The nitrogen content in Romanian country soils have between 0.09-0.35% N. (Lixandru, Gh., 1990)

The fertilization was applied in spring, with four weeks before tomatoes plantation.

Soil samples after crops establishment were collected upon a time with leafs tomatoes samples. In accordance with agrochemicals analysis, the soil agrochemical parameters (pH, humus, nitrogen) were suffered some modification (Table 2).

For Export II sort the lowest nitrogen concentration was in control (0.19%) and to grow up increasing fertilization doses. For Ace Royal variety the high nitrogen concentration was in low mineral doses fertilization and the lowest was found in $N_{120}P_{60}K_{60.}$ This is possible because of urea volatilization process. The first step in urea conversion to $NH_4^+$ is the production of $NH_3$. Escape losses from urea are more likely with warm temperatures. (http://msucares) Ace Royal is middle tardy variety.

Table 2

Soil agrochemical parameters after crops establishment

| Tomatoes varieties | Fertilization doses | pH | Humus [%] | $N_t$ [%] |
|---|---|---|---|---|
| EXPORT II | Control | 5.93 | 3.85 | 0.19 |
| | $N_{30}P_{30}K_{30}$ | 6.19 | 3.22 | 0.20 |
| | $N_{45}P_{45}K_{45}$ | 6.47 | 3.27 | 0.21 |
| | $N_{60}P_{60}K_{60}$ | 6.47 | 3.30 | 0.21 |
| | $N_{120}P_{60}K_{60}$ | 6.46 | 3.25 | 0.21 |
| ACE ROYAL | Control | 6.39 | 2.84 | 0.20 |
| | $N_{30}P_{30}K_{30}$ | 6.36 | 2.79 | 0.20 |
| | $N_{45}P_{45}K_{45}$ | 6.38 | 2.81 | 0.20 |
| | $N_{60}P_{60}K_{60}$ | 6.16 | 2.94 | 0.20 |
| | $N_{120}P_{60}K_{60}$ | 5.92 | 2.85 | 0.19 |

In table 3 was presented the nitrogen content in whole tomato leafs and in table 4 was presented nitrate concentration in tomato fruit.

Nitrogen concentration highest upon a high fertilization doses until $N_{45}P_{45}K_{45}$ ($N_t$ =0.40%) and lowest a highest fertilization doses. The whole leaf total nitrogen values is ranged from 0.30-0.40% N; this percent is favorable from early flowering through full bloom. The full bloom influenced by fruit load but not reflect nutrient export to the fruit.

Table 3

Nitrogen content in tomato leaf

| Tomatoes varieties | Fertilization doses | $N_t$ [%] |
|---|---|---|
| EXPORT II | Control | 0.30 |
| | $N_{30}P_{30}K_{30}$ | 0.34 |
| | $N_{45}P_{45}K_{45}$ | 0.40 |
| | $N_{60}P_{60}K_{60}$ | 0.38 |
| | $N_{120}P_{60}K_{60}$ | 0.34 |
| ACE ROYAL | Control | 0.35 |
| | $N_{30}P_{30}K_{30}$ | 0.38 |
| | $N_{45}P_{45}K_{45}$ | 0.40 |
| | $N_{60}P_{60}K_{60}$ | 0.38 |
| | $N_{120}P_{60}K_{60}$ | 0.38 |

Table 4

Nitrate content in tomato fruit

| Tomatoes varieties | Fertilization doses | $N\text{-}NO_3$ [ppm] |
|---|---|---|
| EXPORT II | Control | 0.27 |
| | $N_{30}P_{30}K_{30}$ | 0.38 |
| | $N_{45}P_{45}K_{45}$ | 0.45 |
| | $N_{60}P_{60}K_{60}$ | 0.34 |
| | $N_{120}P_{60}K_{60}$ | 0.41 |
| ACE ROYAL | Control | 0.29 |
| | $N_{30}P_{30}K_{30}$ | 0.34 |
| | $N_{45}P_{45}K_{45}$ | 0.45 |
| | $N_{60}P_{60}K_{60}$ | 0.38 |
| | $N_{120}P_{60}K_{60}$ | 0.40 |

Tomato fruit collected at thoroughly fruit maturity.

Tomatoes fruit is vegetables with very low $N\text{-}NO_3$ content (< 200 mg/kg $^{-1}$fresh matter) (Santamaria, P., 2006)

The highest concentration was found in $N_{45}P_{45}K_{45}$ doses fertilization (0.45ppm for all varieties) and the lowest was in control (0.27ppm for Export II and 0.29ppm in Ace Royal varieties). All results its many below maximum limits accept of Romanian market. Maximum limits accept for nitrate in tomatoes fruit of was 150 mg/kg fresh matter. (Ordinance no.975/1998).

The conclusions de this study was present in figure1. In control samples and in $N_{60}P_{60}K_{60}$ fertilization doses the nitrogen content in fruit are low at leaf content.

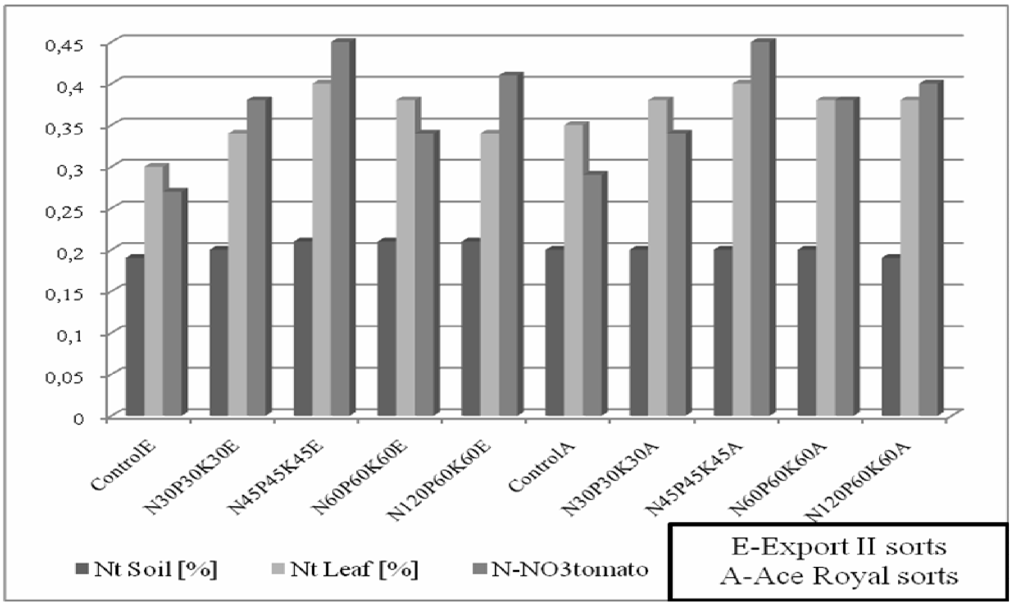


Figure 1

Nitrogen content in soil, leaf and tomato fruit.

## CONCLUSIONS

Nitrogen soil content was reduced after fertilization.

The doses of mineral fertilization applied can also influence nitrogen accumulation in soil, leaf and tomato fruit.

Nitrate content in soil before or at harvest are known to be critical factors in determining nitrate levels in tomato fruit.

Tomatoes sorts did not influence the nitrogen content in fruit.

This area is favorable to ecological vegetables production.

## REFERENCES


1. Brown, J. R., C. Marshall, S. G. Smith, 2007, Nitrate in soils and plants, MU Extension.
2. Flynn, R., 2002, Plant Nutrition and Fertilizers, New Mexico Extension Master Garden Manual-Second Edition, 12.
3. Grierson, D., A. A. Kader, 1986, Fruit ripening and quality in Atherton J.G. and Rudich, J.(eds) The tomato Crop, Chapman and Hall LTD, pg. 241-280.
4. Lixandru, Gh., 1990, Agrochimie, Ed. Didactica si Pedagogica, Bucuresti.
5. Magdoff, F. R. et al., 1984, A soil test for nitrogen availability to corn, Soil Sci.Soc.Am.J.48:1301-1304.
6. Manescu, B., M. Stefan, 2003, Sisteme horticole comparate, Editura Ceres, Bucuresti.
7. Metodologia de analiza agrochimica a solurilor in vederea stabilirii necesarului de amendamente si de ingrasaminte (MAIA), 1983, vol. I, partea1.
8. Relf, D., A. McDaniel, S. Donahue, 2002, Fertilizing the Vegetable Garden, Virginia Tech., Publication Number 426-323.
9. Sainju, M. U. et al., 2003, Mineral nutrition of tomato, Food. Agriculture & Environment , vol.1 (2), 176-183.
10. Sainju, M. U., B. P. Singh, S. Rahman, V. R. Reddy, 1999, Soil nitrate nitrogen under tomato following tillage, cover cropping, and nitrogen fertilization., J. Environ. Qual. 28, 1837-1844.
11. Santamaria, P., A. Elia, F. Serio, E. Todaro, 1999, A survey of nitrate and oxalate content in retail fresh vegetables. J Sci Food Agric 79:1882–1888.
12. Santamaria, P., 2006, Nitrate in vegetables: toxicity, content, intake and CE regulation, J.Sci.Food Agric.86: 10- 17.
13. ***, Ordinance no. 975/1998, Maximun limits accept for nitrate in some vegetables, Romanian Ministry of Public Health.
14. http://msucares.com/crop/soils/nitrogen.html.