

## Modification on some agrochemical soil parameters after tomato mineral fertilization

Moigradean Diana<sup>1\*</sup>, Poiana Mariana-Atena<sup>1</sup>, Alda Liana-Maria<sup>1</sup>, Bordean Despina-Maria<sup>1</sup>, Moisiu Iulia<sup>2</sup>, Alda S.<sup>2</sup>

Banat's University of Agricultural Sciences and Veterinary Medicine, <sup>1</sup>Faculty of Food Processing Technology, <sup>2</sup>Faculty of Horticulture and Sylviculture, Calea Aradului 119, Timisoara, RO 300645, Romania

\*Corresponding author. Email: dimodean@yahoo.com

**Abstract** The main objective of this study is to investigate the modification on some agrochemical soil parameters (pH, humus, total nitrogen, mobile phosphorus and mobile potassium) after three years of tomato NPK fertilization. The study was performed on control soil samples (without fertilizers) and soil samples after differentiated NPK fertilization in variable doses: N<sub>30</sub>P<sub>30</sub>K<sub>30</sub>, N<sub>45</sub>P<sub>45</sub>K<sub>45</sub>, N<sub>60</sub>P<sub>60</sub>K<sub>60</sub> and N<sub>120</sub>P<sub>60</sub>K<sub>60</sub>. The experience was done in a cambic cernosium soil, with low acidity reaction, very good content in nitrogen, phosphorus and potassium and the high natural fertility potential favorable vegetables cultivation in Romanian Western Plain area. The experimental field is located in temperate climatic area, characterized by Koppen classification in the formula Cfbx.

Tomato fertilization with mineral fertilizer determines, in time, significant modifications of agrochemical soil parameters. To preserve the soil quality must find the optimum dose of NPK fertilizer in tomato crop fertilization.

### Key words

agrochemical soil parameters, mineral fertilization, tomatoes

Tomato (*Lycopersicon esculentum*) is one of the popular and most consumed vegetable in the world. Soil is a habitat for plants. The proportions of the four major components of soils: inorganic particles, organic materials, water and the air, can vary greatly from place to place and with depth [15]. Most soils do not naturally possess all the nutrients that are needed to produce top quality yields, crop after crop.

The fertilization doses and the application methods in tomatoes fertilization were to determine in correlations between agrochemistry factors.

The pH value of soil is one of a number of environmental conditions that affects the quality of plant growth. The soil pH value directly affects nutrient availability. Plants thrive best in different soil pH ranges [15]. A slightly acid soil is desirable for most vegetables. Some types of plant growth can occur anywhere in a pH range of 3.5 to 10.0. With some exceptions, a soil pH of from 6.0 to 7.0 is ideal for good plant growth [5]. Optimum soil pH for tomatoes cultivations is between 6.0-6.5 [7].

Humus absorbs the highly active non-nutrient hydrogen sources present in the soil and makes them immediately available as a food source for assimilation and usage by the plant. When carbon, nitrogen, phosphorus and sulfur are associated with humus, they become nutrients for both soil microbe activity as well as plant growth [14].

Nitrogen is a basic component of humus. Nitrogen is one of the main nutrients required for plant

growth and is therefore applied to crops in large amounts to ensure big yields. Nitrogen fertilizer was often used in excess in the past; as a consequence, soil and water were subject to heavy pollution. Concentrations in Romanian soil is between 0.09-0.35% N [6] up to 0.38% N [3].

Phosphorus it has low mobility and availability in soils. It is difficult to manage because it reacts so strongly with both solution and solid phases of the soil. As a result, mobility through the soil is extremely limited. While phosphorus occurs in a multitude of inorganic and organic forms in the soil, the plant available forms of phosphorus are limited primarily to solution  $\text{HPO}_4^{2-}$  and  $\text{H}_2\text{PO}_4^-$ , with the dominant form determined by the soil pH. In soils with pH between 4.3 and 7.0, the  $\text{H}_2\text{PO}_4^-$  form predominates [4]. Phosphorus availability in the soil is generally improved by the addition of N to the P [5]. The total phosphorus content in soil in Romania ranges from 0.05-0.3%  $\text{P}_2\text{O}_5$ , respectively 0.02-0.12% P [3].

Potassium is relatively mobile in the soil, meaning it is readily leached through the soil profile and can be lost from the root zone. Although potassium does move through the soil, if large quantities need to be applied it is best to work it into the soil. Only 1-3% of total soil potassium is potassium exchangeable [3].

The main objective of this study is to investigate the modification on some agrochemical soil parameters after tomato NPK fertilization.

## Material and Method

The experiments were carried out over a period of 3 years: 2006, 2007, 2008. Soil samples were taken 0-25 cm depth and were collected in spring 2006, before the establishment of tomato crop and in each year, in June, after tomato crop establishment. The fertilization was applied in spring, with four weeks before tomatoes plantation [2]. We use dry/granulated fertilizers NPK 15:15:15 and the nitrogen high dose supply with urea application.

pH was determined in aqueous suspension, 1:2.5 soil-solution proportions, using the potentiometric method. The humus was determined by titrimetric method after Walkley-Black (1943). The total nitrogen content was determined by using the Kjeldahl method using UDK 127 Distillation Unit and DK6 model Digester Unit from Velp Scientifica. Mobile phosphorus content was extracted with ammonium lacto-acetate by using the Egner-Riehm-Domingo method (P-AL) using Spectrophotometer UV-VIS SPECORD 205 by Analytik Jena. The concentration of mobile (changeable) potassium was used in the same ammonium lacto-acetate extract

(Egner-Riehm-Domingo method) (K-AL) by flame photometry [13]. Were used chemicals and reagents from Merck; deionized water.

## Results and Discussions

Timisoara city receives, thanks maritime air masses from the northwest, a higher rainfall with a multiannual average values of 631.0 mm. The climate conditions of the area are characterised by average annual temperature of 10.7°C. To characterize the area were used meteorological data recorded at the Meteorological Station of Timisoara, in the years 2006-2008 and multiannual average. In the period when our research was carried out, the temperature values recorded were higher than the multiannual average (Table 1).

Table 2 shows monthly precipitation for three experimental years and annual average. The precipitations has irregular nature. In the second experimental year the total rainfall was the maximum annual sum values (662.4 mm) and in the third year the highest monthly values was in June (157 mm).

Table 1

The air temperatures recorded at the Meteorological Station Timisoara

Years	Monthly average temperatures [°C]												Annual average [°C]
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2006	-1.7	0.0	5.0	12.4	16.2	19.5	23.6	20.1	17.5	12.0	6.4	2.1	11.10
2007	4.0	6.0	9.0	13.0	18.3	22.5	24.1	23.0	14.9	11.0	4.2	0.1	12.51
2008	1.8	4.8	8.3	12.4	17.8	21.6	21.9	22.6	15.4	12.3	7.1	3.6	12.47
Multiannual average [°C]	-1.2	0.4	6.0	11.3	16.4	19.6	21.6	20.8	16.9	11.3	5.7	1.4	10.85

Table 2

The rainfall recorded at the Meteorological Station Timisoara

Years	Monthly average precipitations [mm]												Annual sum [mm]
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2006	30.0	42.0	49.0	78.8	50.2	87.8	50.4	98.0	21.0	17.4	31.3	21.3	577.2
2007	26.0	92.0	57.0	4.4	69.4	65.2	46.4	65.0	62.0	57.0	92.0	26.0	662.4
2008	45.7	22.6	78.4	44.7	49.0	157	45.7	24.8	51.5	17.5	53.1	55.1	645.1
Annual average [mm]	40.9	40.2	41.6	50.0	66.7	81.1	59.8	52.3	47.1	54.8	48.6	47.8	631.0

Soil agrochemical parameters before the experiment were: pH = 6.34, humus = 3.00, N = 0.29%, P = 163.00 ppm, K = 160.00 ppm. The analysis show that soil its favorable for tomatoes cultivation [1, 7].

Over the three experimetal years, soil pH change (Figure 1). pH increases from one experimental year to another of the unfertilizerd variant and the variants fertilized with low NPK fertilization doses and

decreases at higher fertilization doses [8]. While the fertilization with nitrogen, phosphorus and potassium has an significant influence on soil pH, the application of urea nitrogen form to decrease of soil pH and affect availability of plant which for other nutrients.

Rainfall also affects soil pH. Water passing through the soil leaches basic nutrients such as calcium and magnesium from the soil. They are replaced by acidic elements such as aluminum and iron. For this reason, soils formed under high rainfall conditions are more acidic than those formed under arid conditions [15].

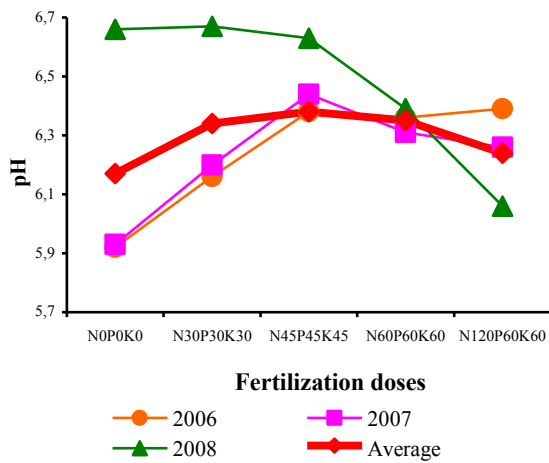


Figure 1. Modification on soil pH after tomato mineral fertilization

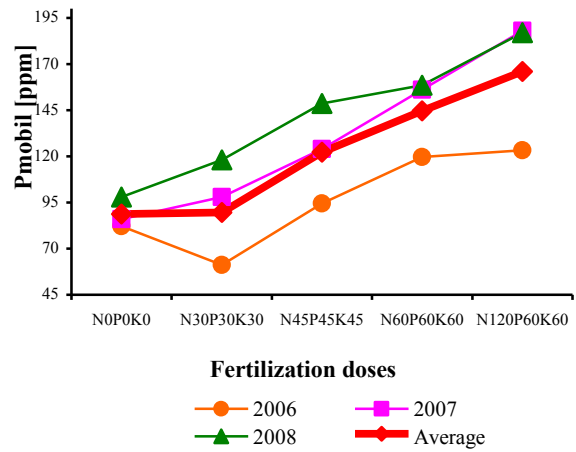


Figure 4. Modification on soil phosphorus after tomato mineral fertilization

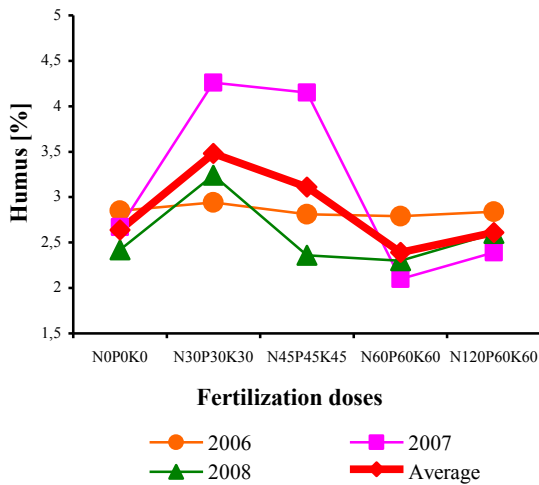


Figure 2. Modification on humus after tomato mineral fertilization

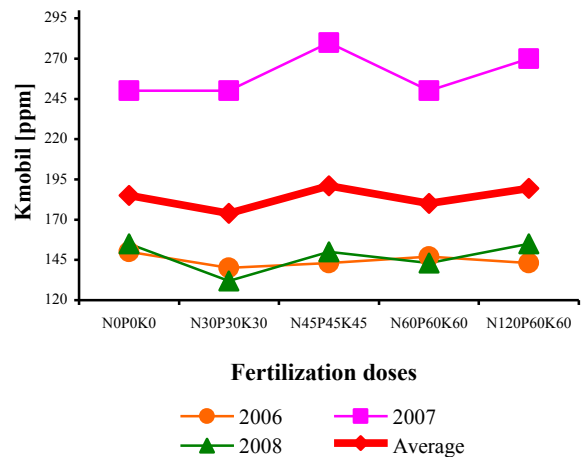


Figure 5. Modification on soil potassium after tomato mineral fertilization

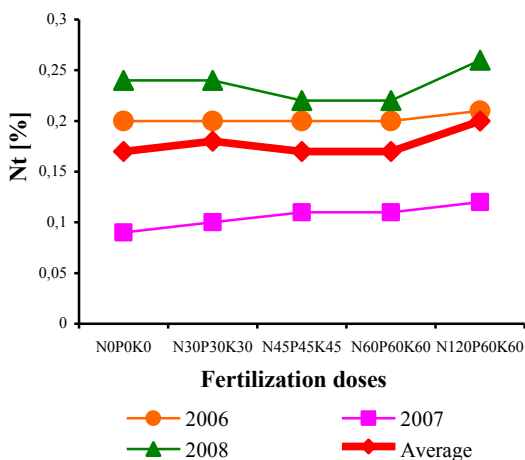


Figure 3. Modification on soil nitrogen after tomato mineral fertilization

In Figure 2 we observed that the humus has a linear dependence in the first experimental year on all fertilization doses. In the second experimental year the humus values shows a jump from the control (2.67%) to  $N_{30}P_{30}K_{30}$  (4.26%) and  $N_{45}P_{45}K_{45}$  (4.15%) fertilization doses, then decreases rapidly at a dose of  $N_{60}P_{60}K_{60}$  (2.1%). At the maximum fertilization doses studied ( $N_{120}P_{60}K_{60}$ ) the humus soil content falling to normal levels. The soil that contains a good humus level stabilizes moisture availability and the soil more readily draws humidity from the air at night. Humus increases the strength of the electromagnetic power of the soil resulting in the faster plant growth [12]. The structure of soil organic matter is extremely complex, with many different types of functional groups which can contribute negative charges as well as interact in other more specific ways with cations and organic molecules. Humus does not readily fix exchangeable cations but maintains these ions in an easily

exchangeable form. Mineralization of soil humus releases some amounts of nitrogen, phosphorous and sulfur from organic forms, and can dramatically influence the availability of micronutrients. The availability of nutrients to plants is determined by the form and chemical properties of the element, the soil pH, interactions with soil colloids, microbial activity and soil physical conditions such as aeration, compaction, temperature, and moisture [4].

Radulov and all. (2009) [10] showed that the total nitrogen content in Romanian soil increases, compared with control samples. The our results showed that the total nitrogen content in soil increases slowly between fertilization doses from 0.2% by 0.21% in 2006, from 0.09% by 0.12% in 2007 and from 0.24% by 0.26% in 2008 (Figure 3). In 2007 the percentage of total nitrogen in the soil is below the average experimental years, has a linear dependence of all fertilization doses because when urea is applied to the soil surface, N loss as gaseous ammonia is possible, especially with warm, dry conditions and a soil high pH [4]. Since, nitrogen is one of the prominent constituents of humus, it is easily understood how a loss of humus has also resulted in a loss of nitrogen [12].

Phosphorus is relatively immobile in soil. Phosphorus moves very slowly in mineral soils and thus tends to build up over time when the amount of phosphorus added in fertilizer and organic matter exceeds the amount removed in the harvested portions of crops [16]. Due the fixation process of phosphates in the soil, only 15-50% of the phosphorus content of mineral fertilizers comes to be used by the plants, the rest is retained in the soil in the form of inaccessible compounds [3]. Mobile phosphorus concentrations increased on all levels of fertilization from one experimental year to another (Figure 4).

Potassium is also mobile in soil; the accumulation of potassium also depends upon soil texture [9] and movement is primarily through diffusion. It is much less mobile than nitrate nitrogen, but more mobile than phosphorus [4]. Potassium is soluble in water and can be leached out of the soil profile into the groundwater [11]. For tomato a significant fraction of the absorbed K is partitioned to fruit [7]. Only 1-3% of total potassium in soil is potassium changeable [3].

Potassium content is within the limits of the control samples values. Potassium remains from the soil in the same range [8], between 140-147 ppm from the experimental year 2006 and 132-155 ppm from 2008 (Figure 5). The potassium content of soil in 2007 was more than average experimental years, due to the meteorological conditions: low rainfall and high temperatures values. The highest value of potassium soil was observed by N<sub>45</sub>P<sub>45</sub>K<sub>45</sub> fertilization doses (280 ppm).

## Conclusions

The experience was done in a cambic cernosium soil, with low acidity reaction, very good content in nitrogen, phosphorus and potassium and the high natural fertility potential favorable tomatoes cultivation.

The soil acidity increases with mineral fertilizers application from the slightly acid pH to moderately acid pH.

Fertilization with mineral fertilizers in small and average doses determines annual linear increase of nitrogen soil and considerable variations to high doses of fertilizer.

Mobile phosphorus concentrations in soil have increased from one experimental year to another due to residual effect of the phosphorus fertilizers in the soil and the meteorological conditions.

Potassium accumulation in soil depends of soil texture and the meteorological conditions.

To preserve the soil quality must find the optimum dose of NPK fertilizer in tomato crop fertilization.

## References

1. Davidescu, D., Davidescu, V. (1992): *Agrochimie Horticola*. Editura Academiei Romane. Bucuresti
2. Dumas, Y., Dadomo, M., Lucca, G., Grolier P. (2003): Effects of environmental factors and agricultural techniques on antioxidant content of tomatoes. *Journal of the Science of Food and Agriculture* 83, pp.369–382
3. Goian, M., Borza I., Radulescu, H., Sala F. (1994): *Agrochimie*. LITO-USAB Timisoara
4. Hodges, C.S. (2010): *Soil Fertility Basics*. NC Certified Crop Advisor Training. North Carolina State University
5. Haby V. A., Marvin L. Baker, and Sam Feagley (2011), Chapter III. *Soils and Fertilizers*, Texas Vegetable Growers' Handbook
6. Lixandru, G. (1990): *Agrochimie*. Editura Didactica si Pedagogica, Bucuresti
7. Manescu, B., Stefan, M. (2003): *Sisteme horticole comparate*. Editura Ceres Bucuresti
8. Moigradean D. Poiana M.A., Alda L.M., Alda S., Bordean D.M. (2012): Change in time of agrochemical soil parameters after tomato mineral fertilization, *Scientific Journal of University of Szeged, Faculty of Agriculture*, 2012/1, pp.370-375
9. Osmond, L.D., Kang, J. (2008): *Nutrient removal by crops in North Carolina* published by North Carolina Cooperative Extension Service
10. Radulov, I., Sala, F., Berbecea, A., Crista, F. (2009): Influence of mineral fertilization treatments on soil chemical properties. *Research people and actual tasks on multidisciplinary sciences*, Lozenec, Bulgaria, pp.321-327

11. Sainju, M.U., Dris, R., Singh, B. (2003): Mineral nutrition of tomato. Food. Agriculture & Environment, vol.1 (2), pp.176-183
12. Snyder, H., B. SC., Humus in relation to soil fertility. Yearbook of the U. S. Department of agriculture,  
<http://naldc.nal.usda.gov/download/ind23311203/pdf>
13. \*\*\*Agrochemical soil analysis methodology for establish the need amendments and fertilizers (MAIA), 1983, vol. I (1)
14. <http://www.globalmkg.com/humus.htm>
15. [http://www.savvygardener.com/Features/soil\\_ph.html](http://www.savvygardener.com/Features/soil_ph.html)
16. <http://www.soil.ncsu.edu/publications/Soilfacts/ag-439-16W.pdf>