INFLUENCE OF FERTILIZATION TREATMENTS ON NITRATES CONTENT OF SOME VEGETABLE SPECIES CULTIVATED IN THE FIELD

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Abstract: *The existing amount of nitrates in plant at a given time is the result of balance between the amount absorbed and used in protein-genesis. A main cause of nitrate accumulation in vegetables is the use of nitrogenous fertilizers on crop land.*
High concentration of nitrates in plants (especially in vegetables) means a hazard for human and animal body, for two reasons: possibility of methemoglobin appearance at children and nitrates conversion to nitrites in saliva and formation of cancerigen nitrosamines in the intestinal tract.
This paper presents the results of researches made in order to establish the influence of fertilization treatments on nitrates content of some vegetable species, cultivated in the field: egg plants, green peppers, bell peppers and carrots. In the culture technology of these vegetables, the following fertilization variants were applied (fertilizer being ammonium nitrate with 33% nitrogen): V1 = 0 kg nitrogen/ha; V2 = 100 kg nitrogen/ha; V3 = 200 kg nitrogen/ha; V4 = 400 kg nitrogen/ha; V5 = 800 kg nitrogen/ha.
In order to establish the accumulation potential of nitrates in vegetables cultivated in the field, an enzymatic method was used.
When no fertilizer was added in the culture, bell peppers had the minimum value of the nitrates content (11.53 mg NO_3^-/kg), and carrots the maximum one (90.42 mg NO_3^-/kg).
In the case of the highest fertilization level, carrots had the highest nitrates content (391.20 mg NO_3^-/kg), and bell peppers the lowest one (63.08 mg NO_3^-/kg).

Key words: *egg plants, green peppers, bell peppers, carrots, nitrates*

Introduction

Achieving a sustainable soil fertility reintegration involves the mineral, plant and animal in its natural flow. Under natural conditions, soil organic matter is maintained in terms of intake of animal and vegetable, devoid of life, which falls on the surface of the land mass of dead roots, soil microorganisms that die, all incorporated by biological cycles characteristic of biocenoses [1].
Fertilizer application is made on the basis of careful analysis for each crop separately and for each type of soil, taking into account that their use in uncontrolled quantities can pollute soil, groundwater and end products. When determining the dose of fertilizer, the following aspects should be taken into consideration: nutrients in the soil, the degree of assurance of water plants, pre-plant, the planned production on cultivated plot [2].
Naturally, between nitrates and nitrites in soil, water and plants equilibrium is established, which can be disrupted by intensive use in agriculture of natural organic fertilizers and of those synthetic nitrates, especially. Their degradation products enrich the soil and they can be accumulated in the cultivated plants until deleterious levels for consumers.

Vegetables and fruits can also accumulate nitrogen as nitrates and nitrites form. Mineral nitrogen amount in tissues of vegetable and fruit is higher in the case of species at which nitrates reductions is made in leaves and when light intensity and temperature are lower [3].
The factors determining the nitrates accumulation in cultivated horticultural products within protected environments (greenhouses, solar) or in the open field are [4]:

- genetical potential of species
- high doses of mineral fertilizers with nitric nitrogen, applied to cultures
- low temperature
- reduced light intensity
- maintenance system of soil

Experimental

We carried out a study to determine the influence of fertilization treatments on nitrates content of some vegetable species, cultivated in open field: egg plants **(***Zaraza* variety), green peppers (*Buzău 10* variety), bell peppers (*Splendens* variety), and carrots (*Nabuco* variety).
The samples were supplied by the Vegetable Research Development Plant for Horticulture Buzau. In the culture technology of these vegetables, the following fertilization variants were applied (fertilizer being ammonium nitrate with 33% nitrogen): V1 = 0 kg nitrogen/ha; V2 = 100 kg nitrogen/ha; V3 = 200 kg nitrogen/ha; V4 = 400 kg nitrogen/ha; V5 = 800 kg nitrogen/ha. For each fertilization variant, we made 4 repetitions.
To determine the accumulation potential of nitrates in vegetables cultivated in open field, an enzymatic method was used. In this method, nitrate is reduced by the reduced nicotinamide adenine dinucleotide (NADPH), to nitrite, in the presence of nitrate-reductase (NR) [5]:

$$NO_3^- + NADPH + H^+ \xrightarrow{NR} NO_2^- + NADP^+ + H_2O$$

The amount of oxidized NADPH is stoechiometrically equal to the nitrate one. Decreasing of NADPH amount is measured by absorbance at ג = 340 nm.

Figure 1. Kit for nitrates determination through enzymatic method

Results and Discussion

In the case of experimental variant V1 (without fertilizer addition), the nitrates content of egg plants is in the range 41.15 – 44.55 mg NO_3^-/kg. The average value of accumulation potential of nitrates, in this case is 42.61 mg NO_3^-/kg.
In the case of fertilizer application, the nitrates content of egg plants increases with fertilizer dose (ammonium nitrate with 33% nitrogen). Thus, in the case of fertilization variant V2 (100 kg nitrogen/ha) the egg plants have the nitrates content in the range 81.95 – 84.67 mg NO_3^-/kg, and the average accumulation potential of nitrates is 83.22 mg NO_3^-/kg, with 95.30% much higher than in the case when no fertilizer is applied.
In the case of fertilization variant V3 (200 kg nitrogen/ha) the egg plants have a nitrates content in the range 137.59 – 143.25 mg NO_3^-/kg, and the average accumulation potential of nitrates is 140.56 mg NO_3^-/kg, approximately 3.3 times higher than in the case when no fertilizer is applied.
The application of fertilizer dose of 400 kg

nitrogen/ha (fertilization variant V4), determines an increase of 4.83 times of the average accumulation potential of nitrates in egg plants cultivated under these conditions, in comparison with those non-fertilized ones. In the case of this fertilization variant, egg plants have nitrates content in the range 203.55 – 209.23 mg NO_3^-/kg, and the average accumulation potential of nitrates is 206 mg NO_3^-/kg.

The use within culture technology of a fertilizer dose of 800 kg nitrogen/ha (fertilization variant V5), determines an increase of 7.11 times of the average accumulation potential of nitrates within the egg plants cultivated under these conditions, in comparison with those non-fertilized ones. In the case of this fertilization variant, the egg plants have nitrates content in the range 295.37 – 308.19 mg NO_3^-/kg, and the average accumulation potential of nitrates is 303.05 mg NO_3^-/kg.

According to the achieved results, egg plants are a vegetable species with an average accumulation potential of nitrates.

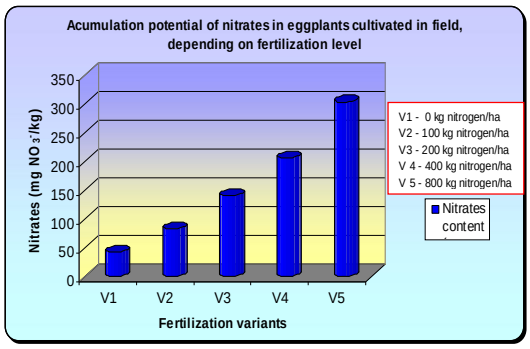

Figure 2. Accumulation potential of nitrates in egg plants cultivated in the field, depending on fertilization level

Between the fertilization level with nitrogen of egg plants culture and accumulation potential of nitrates in egg plants, a linear correlation is established, described by the equation

y = 0.3216x + 58.607, linearity coefficient (R^2) being 0.9732.

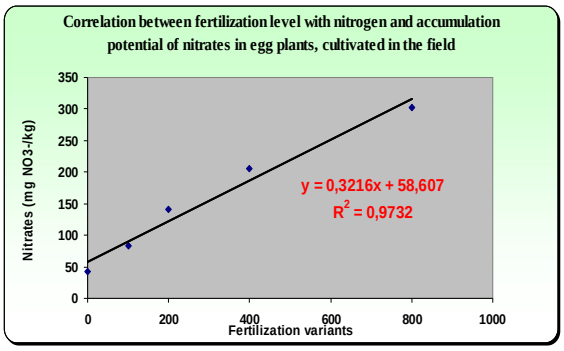

Figure 3. Correlation between fertilization levels with nitrogen and accumulation potential of nitrates in egg plants, cultivated in the field

In the case of experimental variant V1 (without fertilizer addition), the nitrates content of green peppers is in the range 19.8 – 21.57mg NO_3^-/kg. And the average value of accumulation potential of nitrates, in this case, is 20.79 mg NO_3^-/kg.

In the case when fertilizer is applied, the nitrates content of green peppers increases with fertilizer dose (ammonium nitrate with 33% nitrogen). Thus, in the case of fertilization variant V2 (100 kg nitrogen/ha) green peppers have the nitrates content in the range 32.28 – 33.05 mg NO_3^-/kg, and average accumulation potential of nitrates is 32.58 mg NO_3^-/kg, with 56.71% much higher than in the case when no fertilizer is applied.

In the case of fertilization variant V3 (200 kg nitrogen/ha) green peppers have the nitrates content in the range 46.24 – 49.77 mg NO_3^-/kg, and the average accumulation potential of nitrates is 48.02 mg NO_3^-/kg, approximately 2.31 times higher than in case when no fertilizer is applied.

The application of fertilizer dose of 400 kg nitrogen/ha (fertilization variant V4), determines an increase 3.23 times of the average accumulation potential of nitrates in green peppers under these conditions, in comparison with those non-fertilized ones. In the case of this fertilization variant green peppers have nitrates content in the range 65.74 – 68.80 mg NO_3^-/kg, and the average accumulation potential of nitrates is 67.14 mg NO_3^-/kg.

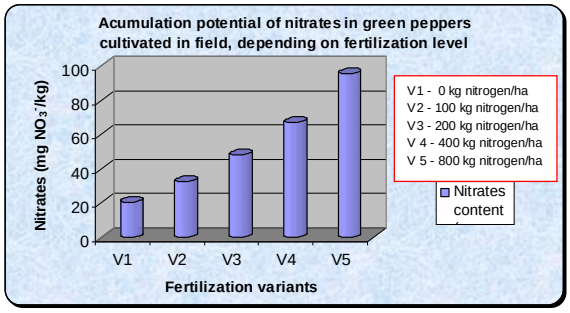

Figure 4. Accumulation potential of nitrates in green peppers cultivated in the field, depending on fertilization level

The use within the culture technology of fertilizer dose of 800 kg nitrogen/ha (fertilization variant V5), determines an increase 4.59 times of the average accumulation potential of nitrates in green peppers cultivated under these conditions, in comparison with those non-fertilized ones. In the case of this fertilization variant, the achieved green peppers have nitrates content in the range 93.56 – 98.34 mg NO_3^-/kg, and the average accumulation potential of nitrates is 95.41 mg NO_3^-/kg.

Between the fertilization level with nitrogen of green peppers culture in field and accumulation potential of nitrates in green peppers, a linear correlation is established, described by the equation y = 0.0922x + 25.14, linearity coefficient (R^2) being 0.9769.

According to the achieved results, green peppers are a vegetable species with low accumulation potential of nitrates.

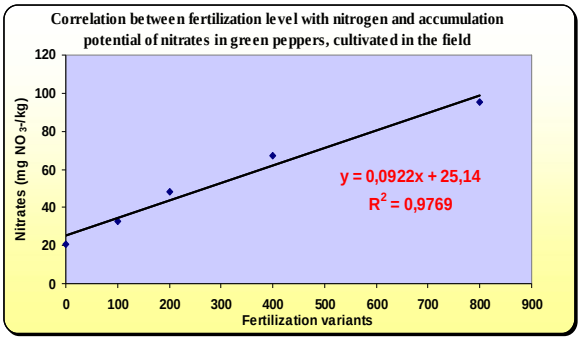

Figure 5. Correlation between fertilization level with nitrogen and accumulation potential of nitrates in green peppers, cultivated in the field

Within the fertilization variant V1 (without fertilizer addition), the nitrates content of bell peppers is in the range 11.53 – 14.04 mg NO_3^-/kg. The average value of the accumulation potential of nitrates in this case is 12.63 mg NO_3^-/kg.

When fertilization is applied, nitrates content of bell peppers increases once with increasing of fertilizer dose (ammonium nitrate with 33% nitrogen). Thus, in the case of fertilization variant V2 (100 kg nitrogen/ha) bell peppers have a nitrates content in the range 17.03 – 19.25 mg NO_3^-/kg, and the average accumulation potential of nitrates is 18.17 mg NO_3^-/kg, with 43.86% much higher than in the case when no fertilizer is applied.

Within the fertilization variant V3 (200 kg nitrogen/ha) bell peppers have a nitrates content in the range 27.10 – 29.35 mg NO_3^-/kg, and the average accumulation potential of nitrates is 28.08 mg NO_3^-/kg, of 2.22 times higher, than in the case when no fertilizer is applied.

The application of a fertilizer dose of 400 kg nitrogen/ha (fertilization variant V4) determines an increase of 3.22 times of the average accumulation potential of nitrates in bell peppers cultivated under these conditions, in comparison with those non-fertilized ones. In the case of this fertilization variant bell peppers have nitrates content in the range 39.67 – 41.55 mg NO_3^-/kg, and the average accumulation potential of nitrates is 40.67 mg NO_3^-/kg.

The use in the culture technology of a fertilizer dose of 800 kg nitrogen/ha (fertilization variant V5) determines an increase of 4.88 times of the average accumulation potential of nitrates in bell peppers cultivated under these conditions, in comparison with non-fertilized ones. In the case of this fertilization variant, bell peppers have the nitrates content in the range 60.85 – 63.08 mg NO_3^-/kg, and the average accumulation potential of nitrates is 61.70 mg NO_3^-/kg.

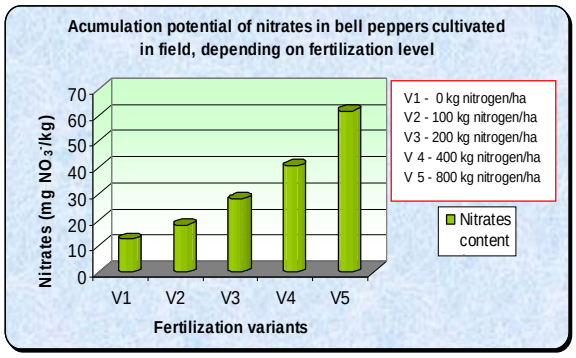

Figure 6. Accumulation potential of nitrates in bell peppers cultivated in the field, depending on fertilization level

Between the fertilization level with nitrogen of culture of bell peppers in the field and accumulation potential of nitrates in bell peppers, a linear correlation is established, described by the equation y = 0.0617x + 13.736, linearity coefficient (R^2) being 0.9901.

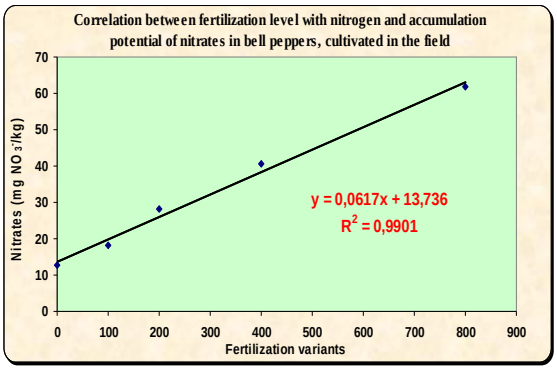

Figure 7. Correlation between the fertilization level with nitrogen and accumulation potential of nitrates in bell peppers, cultivated in the field

According to the obtained results, bell peppers are a vegetable species with low potential of nitrates accumulation.

Within the fertilization variant V1 (without fertilizer addition), the nitrates content of carrots is in the range 90.18 – 91.88 mg NO_3^-/kg. The average value of the accumulation potential of nitrates in this case is of 90.85 mg NO_3^-/kg.

When fertilizer is applied, the nitrates content of carrots increases once with increasing the fertilizer dose (ammonium nitrate with 33% nitrogen). Thus, in the case of fertilization variant V2 (100 kg nitrogen/ha) carrots have a nitrates content in the range 159.55 – 161.93 mg NO_3^-/kg, and the average accumulation potential of nitrates is 160.98 mg NO_3^-/kg, with 77.19% much higher than in the case when no fertilizer is applied.

Within the fertilization variant V3 (200 kg nitrogen/ha) carrots have a nitrates content in the range 199.85 – 201.85 mg NO_3^-/kg, and the average accumulation potential of nitrates is 200.83 mg NO_3^-/kg, of 2.21 times higher than in the case when no fertilizer is applied.

The application of a fertilizer dose of 400 kg nitrogen/ha (fertilization variant V4) determines an increase of 2.87 times of the average accumulation potential of nitrates in carrots cultivated under these conditions, in comparison with those non-fertilized ones. In the case of this fertilization variant carrots have nitrates content in the range 260.53 – 261.44 **mg** NO_3^-/kg, and the average accumulation potential of nitrates is 260.62 mg NO_3^-/kg.

The use in the culture technology of a fertilizer dose of 800 kg nitrogen/ha (fertilization variant V5) determines an increase of 4.3 times of the average accumulation potential of nitrates in carrots cultivated under these conditions, in comparison with non-fertilized ones. In the case of this fertilization variant, carrots have the nitrates content in the range 389.72 – 391.50 mg NO_3^-/kg, and the average accumulation potential of nitrates is 390.49 mg NO_3^-/kg.

Between the fertilization level with nitrogen of culture of carrots in field and accumulation potential of nitrates in carrots a linear correlation is established, described by the equation y = 0.3544x + 114.42, linearity coefficient (R^2) being 0.9806.

According to the obtained results we have drawn the conclusion that carrots are a vegetable species with an average accumulation potential of nitrates.

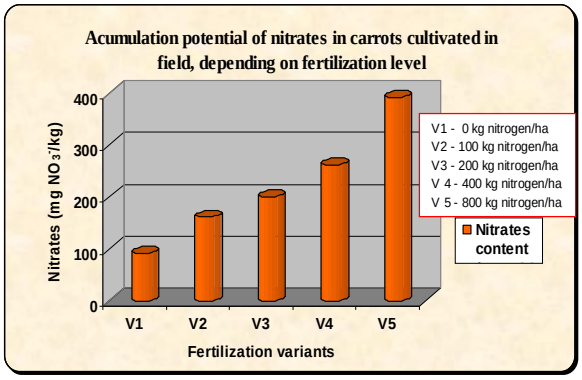

Figure 8. Accumulation potential of nitrates in carrots cultivated in the field, depending on fertilization level

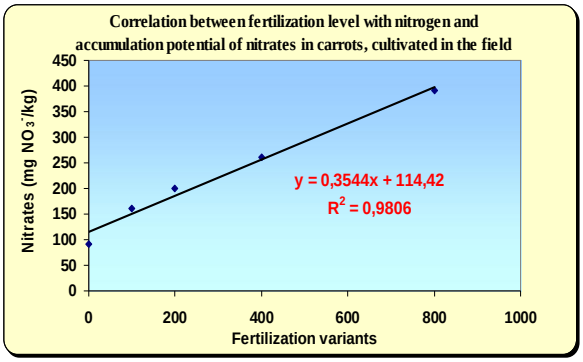

Figure 9. Correlation between the fertilization level with nitrogen and accumulation potential of nitrates in carrots, cultivated in the field

Conclusions

1. Egg plant samples achieved within culture in the field, through application of 5 fertilization variants, have an accumulation potential of nitrates in the range: 42.61 mg NO_3^-/kg – 303.05 mg NO_3^-/kg. The minimum value of nitrates content is for non-fertilized egg plants, and the maximum value is for fertilized egg plants with 800 kg nitrogen/ha.
2. Green pepper samples achieved within culture in the field, through application of 5 fertilization variants, have an accumulation potential of nitrates in the range: 20.79 mg NO_3^-/kg – 95.41 mg NO_3^-/kg. The minimum value of nitrates content is for non-fertilized green peppers, and the maximum value is for fertilized green peppers with 800 kg nitrogen/ha.
3. Bell pepper samples obtained in the field culture, through application of 5 fertilization variants, have an accumulation potential of nitrates in the range: 12.63 mg NO_3^-/kg – 61.70 mg NO_3^-/kg. The minimum value of nitrates content is for non-fertilized bell peppers, and the maximum value is for fertilized bell peppers with 800 kg nitrogen/ha.
4. Carrot samples obtained in the field culture, through application of 5 fertilization variants, have an accumulation potential of nitrates in the range: 90.85 mg NO_3^-/kg – 390.49 mg NO_3^-/kg. The minimum value of nitrates content is for non-fertilized carrots, and the maximum value is for fertilized carrots with 800 kg nitrogen/ha.

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