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# A COMPARATIVE ANALYSIS FOR A CONTENT OF MANGANESE IN PLANTS

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**ABSTRACT**

A certain research has been carried out for the content of manganese in leaf mass of eggplant under the influence of soil fertilization and leaf fertilization. In connection with this aspect some leaf fertilizers have been tested, such as: Fitona, Hortigrow, Agroleaf, Kristalon.

A new extraction – spectrophotometric method for the determination of manganese with Methylene Blue in plant material was used. The method is simple and rapid with satisfactory results and good reproducibility.

The content of manganese is higher in leaf mass of eggplant in the treatment of plants with the leaf fertilizer Kristalon – 138.6 mg kg$^{-1}$ Mn. By all means this is due to the fact that the leaf fertilizer Kristalon comprises in its composition 0.04% Mn. The effect of the leaf feeding-up takes place much promptly in comparison to the soil fertilization.

The content of microelement manganese in leaf mass of eggplant was determined in mixed fertilization (soil and leaf). The experimental data show that the highest is the content of Mn 142.2 mg kg$^{-1}$ in fertilization with $N_{24}P_{12}K_{12}$ and leaf fertilizer Kristalon.

*Keywords: manganese, methylene blue, spectrophotometry, plants, leaf fertilization.*

## INTRODUCTION

In the conditions of intensive farming, the problem of trace elements in the soil-plant system attained significant importance. In the process of feeding-up of plants ten of the most importanat elements are comprised, and manganese is between them.

Manganese is important for the synthesis of the organic substance in plants and the metabolism of a number of nutrient elements in a plant organism. Manganese takes part in a number of important physiological and biological processes – in the nitrogen metabolism, photosynthesis, breathing the needed oxidation-reduction conditions in the cell [1, 2].

Manganese is an element which is important for the nitrogen metabolism in plants. Manganese insufficiency leads to a considerable accumulation of nitrates, disturbance in the protein synthesis in plants and illness to some plants [3–5]. Also the manganese insufficiency causes a decrease in Ca and Mg contents in plants [6]. The optimal content of manganese, its critical level and toxic concentration at which the growth is depressed and the yield decreased, have been established for a great number of crops [7].

Various methods for determination of manganese have been published. Analyses with some reagents are used [8–14].

The objectivity of this study is to clarify the opportunity for using Methylene Blue [15] as a reagent for determination of micro quantities of manganese in plant samples. To explore the influence of the mineral fertilization and leaf fertilizers upon the assimilation of manganese in leaf mass of eggplants.

## MATERIAL AND METHODS

The experiment was carried out in ten variants: non frtilized, soil fertilization, leaf fertilization and mixed fertilization (soil with leaf).

***Variants of the experiment:***

1. Control – non fertilized
2. Soil fertilization $N_{24}P_{12}K_{12}$
3. Leaf fertilization Fitona
4. Leaf fertilization Hortigrow
5. Leaf fertilization Agroleaf
6. Leaf fertilization Kristalon
7. $N_{24}P_{12}K_{12}$ + Fitona
8. $N_{24}P_{12}K_{12}$ + Hortigrow
9. $N_{24}P_{12}K_{12}$ + Agroleaf
10. $N_{24}P_{12}K_{12}$ + Kristalon

An analysis for manganese content by variants were carried out using a new extraction-spectrophotometric method with Methylene Blue (MB) [15]. Manganese(VII) forms an ion-association complex with triphenylmethane dye MB. The molar absorptivity of the ion-association complex is $(1 \pm 0{,}08)\text{x}10^4$ L mol$^{-1}$ cm$^{-1}$ at 245 nm. The system obeys Beer's law in the range $1.7\text{x}10^{-4}$ mol L$^{-1}$ – $5\text{x}10^{-4}$ mol L$^{-1}$ Mn(VII). A rapid and selective extractive-photometric method for determination of manganese in plants was developed. The determination was carried out without preliminary separation of manganese.

***Apparatus*** – Spectrophotometer UV–VIS with 1-cm light path quartz cells.

***Procedure*** – A wet burning of the plant sample was carried out in which a mixture of sulphuric and nitric acids was used for the oxidation of the organic substance. A portion of 2 g of air-dry plant material was placed into a Kjeldal flask and moistened with 4 ml distilled water. 5 mL conc. sulphuric acid and 10 mL conc. nitric acid were added. The flask was slightly heated. If the oxidation of the organic substance was not completed, $HNO_3$ was added and heated again. When all the organic material was oxidized, the solution was heated at a higher temperature for 10 min [16]. After cooling the solution was diluted with water and filtered. Portions of 3 mL conc. $H_2SO_4$, 2 mL conc. $H_3PO_4$ and 0,1 g potassium periodate were added for oxidation Mn(II) to Mn(VII). It was heated to boiling point and the temperature was maintained for 10 min [17]. After cooling the solution was diluted with water and filtered. It was transferred into a volumetric flask of 50 mL and diluted to the mark with distilled water. Aliquot parts of this solution were taken for analysis.

In separatoly funnel of 100 mL are introduced the solutions: 4 mL of 1.2 mol $L^{-1}$ HCl, 0.5 mL of $1x10^{-2}$ mol $L^{-1}$ Methylene Blue, and aliquot part of the plant sample solution, 2 mL of each – saturated solutions of ascorbic acid and tartaric acid (to mask the interfering ions). It is diluted up to a volume of the aqueous phase of 12 mL with distilled water and extracted with 3 mL 1,2 dichloroethane for 5 s. The organic layer is then transferred through paper filter into a 1 cm cuvette and photometered on spectrophotometer at 245 nm against the pure solvent. A blank is run parallel in the absence of plant sample. A standard curve was used for determination of manganese.

## RESULTS AND DISCUSSION

A certain research has been carried out for the content of manganese in leaf mass of eggplant under the influence of soil fertilization and leaf fertilization Table 1. In connection with this aspect some leaf fertilizers have been tested, such as: Fitona, Hortigrow, Agroleaf, Kristalon. Manganese in some plant samples is determined with a new extraction-spectrophotometric method with Methylene Blue [15].

As we can discern from Fig. 1 the content of manganese is higher in leaf mass of eggplant in the treatment of plants with the leaf fertilizer Kristalon – 138.6 mg $kg^{-1}$ Mn. By all means this is due to the fact that the leaf fertilizer Kristalon comprises in its composition 0.04% Mn. Content of manganese in leaf mass of eggplant samples increases consequently in the line of the used leaf-fertilizers Hortigrow, Agroleaf, Fitona and Kristalon.

The leaf feeding-up is due to the ability of leaves and stems to absorb the nutritious elements taken in them in the form of certain silutions. The effect of the leaf feeding-up takes place much promptly in comparison to the soil fertilization. It is also very important to mention that the physiological deseases of plants caused by deficiency or scarcity of a given element can be avoided.

**Table 1.** *Content of manganese in leaf mass of eggplant samples in mineral fertilization and leaf treating*

| № | Variants | Mn, mg $kg^{-1}$ MB method | RSD* % | Mn, mg $kg^{-1}$ AAS |
|---|---|---|---|---|
| 1 | Control – non fertilized | 97.8 | 1.6 | 97.5 |
| 2 | $N_{24}P_{12}K_{12}$ | 128.8 | 1.2 | 128.2 |
| 3 | Fitona | 108.8 | 1.5 | 109.3 |

| | | | | |
|---|---|---|---|---|
| 4 | Hortigrow | 79.6 | 2.1 | 79.1 |
| 5 | Agroleaf | 97.8 | 1.9 | 98.2 |
| 6 | Kristalon | 138.6 | 1.3 | 139.0 |
| 7 | $N_{24}P_{12}K_{12}$ + Fitona | 112.4 | 1.7 | 111.9 |
| 8 | $N_{24}P_{12}K_{12}$ + Hortigrow | 135.6 | 1.4 | 135.2 |
| 9 | $N_{24}P_{12}K_{12}$ + Agroleaf | 99.5 | 2.2 | 99.8 |
| 10 | $N_{24}P_{12}K_{12}$ + Kristalon | 142.2 | 1.5 | 141.8 |

* Relative Standard Deviation for MB method (bazed on 5 determination)

In order to study the influence of different kinds of fertilization, the content of microelement manganese in leaf mass of eggplant was determined in mixed fertilization (soil $N_{24}P_{12}K_{12}$ + leaf). The experimental data Fig. 2 show that the highest is the content of Mn 135.6 mg $kg^{-1}$ in leaf mass of eggplant in fertilization with $N_{24}P_{12}K_{12}$ and leaf fertilizer Hortigrow (variant 1) and respectively 142.2 mg $kg^{-1}$ Mn in fertilization with $N_{24}P_{12}K_{12}$ and leaf fertilizer Kristalon (variant 4).

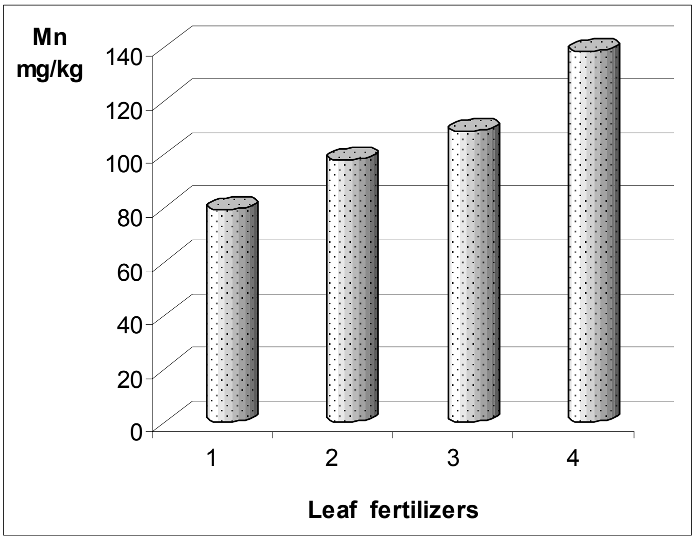


**Figure 1.** *Content of Mn in leaf mass of eggplant in fertilization with leaf fertilizers: 1 – Hortigrow, 2 – Agroleaf, 3 – Fitona, 4 – Kristalon*

From fig. 2 it can be discerned that in mixed fertilization the content of manganese does not increase consequently in the line Hortigrow, Agroleaf, Fitona, Kristalon as in the leaf fertilization. This all indicates that soil fertilization with nitrogen, phosphorus and potassium ($N_{24}P_{12}K_{12}$) influences the accumulation of manganese in leaf mass of eggplant.

The experimental data show that in the two variants of fertilization – leaf and mixed fertilization, the content of manganese is highest in the leaf-fertilizer Kristalon.

The accuracy of the method was checked up using atomic-absorption method. The experimental data (Table 1) show a good agreement between the results obtained by the two methods.

The experimental data by both methods show that the proposed extraction-photometric method with Methylene Blue can be successfully used for determination of microquantities of manganese in plant material. This is an extremely simple and direct extraction for determination of microquantities of manganese.

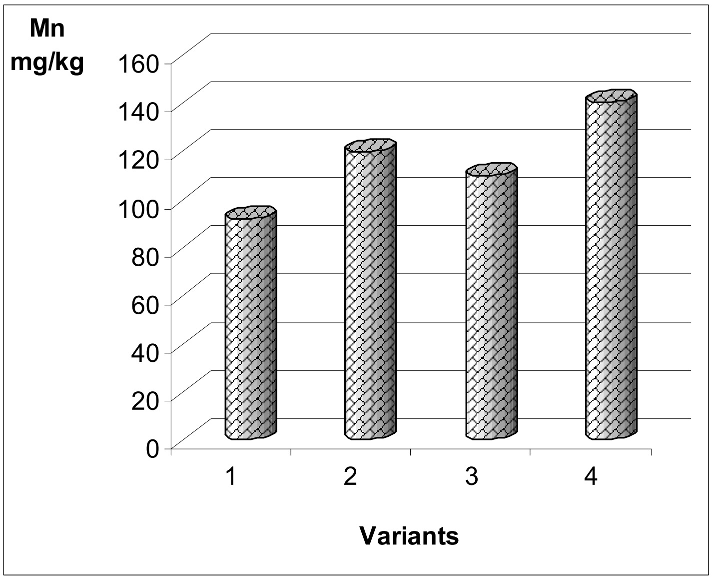


**Figure 2.** *Content of Mn in leaf mass of eggplant in mixed fertilization (soil and leaf);*
*Variants: 1 – $N_{24}P_{12}K_{12}$ + Hortigrow*
*2 – $N_{24}P_{12}K_{12}$ + Agroleaf*
*3 – $N_{24}P_{12}K_{12}$ + Fitona*
*4 – $N_{24}P_{12}K_{12}$ + Kristalon*

## CONCLUSION

A new extraction – spectrophotometric method for the determination of manganese with Methylene Blue in plant material was used. The method is simple and rapid with satisfactory results and good reproducibility.

Manganese is determined in leaf mass of eggplant under the influence of soil fertilization and leaf fertilization.The content of manganese is higher in leaf mass of eggplant in the treatment of plants with the leaf fertilizer Kristalon – 138.6 mg $kg^{-1}$ Mn. By all means this is due to the fact that the leaf fertilizer Kristalon comprises in its composition 0.04% Mn.

The content of microelement manganese in leaf mass of eggplant was determined in mixed fertilization (soil and leaf). The experimental data show that the highest is the content of Mn 142.2 mg $kg^{-1}$ in fertilization with $N_{24}P_{12}K_{12}$ and leaf fertilizer Kristalon.

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