

Effect of type and method of fertilization on marrows (*Cucurbita pepo* L.) yield and fruit quality

Denka Kostova*¹, Dimka Haytova*¹, Dimitar Mechandjiev²

¹Agricultural university, 12 Mendeleev str. 4000 Plovdiv, Bulgaria

²Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, Acad. G. Bonchev Str., Bl. 11, 1113 Sofia, Bulgaria

ABSTRACT

Aims: The main aim of this study is to determine the influence of foliar and soil fertilization upon the nutritious value of fruit of marrows and to clarify the opportunity for using Blue tetrazolium chloride [1] as a reagent for determination of micro quantities of manganese in plant samples. The BTC method can be successfully applied to the determination of manganese in plant samples.

Study design: The investigation was conducted in the period 2007–2009 in an open field condition with the marrows (*Cucurbita pepo* L. var. *giromontia*) cultivar Izobilna F₁ on the experimental field of the Agricultural University of Plovdiv, Bulgaria.

Methodology: Treatments of the experiment: 1. Control - non fertilized; 2. Foliar fertilization with 0.3 % Fitona; 3. Foliar fertilization with 0.3 % Hortigrow; 4. Foliar fertilization with 0.3 % Humustim; 5. Soil fertilization with N₁₆P₁₆K₁₆; 6. Soil fertilization with N₁₆P₁₆K₁₆ + 0.3 % Fitona; 7. Soil fertilization with N₁₆P₁₆K₁₆ + 0.3 % Hortigrow; 8. Soil fertilization with N₁₆P₁₆K₁₆ + 0.3 % Humustim; Total carbohydrates were determined using the method of Haygedorn – Jensen. Plant dry matter was determined according to the method of Stanchev et al. The content of nitrates of fruits was determined with test method GOST 29270-95. Manganese was determined in the fruits of marrows [1]. Materials were collected in the phase of mass fruit production

Results: The results show that application of foliar fertilizers Fitona, Hortigrow and Humustim and increased yields of zucchini in preserved and improved product quality, the dry matter, total sugars and content of nitrates in fruits. The effect occurred more strongly when it was applied on a background of soil fertilization. The BTC method can be successfully applied to the determination of manganese in plant samples.

Conclusion: The use of foliar fertilizers containing different macro- and micronutrients in the period of growing marrows influenced on the content of Mn in their fruit. The highest content of Mn in the fruits of zucchini was found after combined soil and foliar fertilization with 0.3% Hortigrow

The decrease in yield induces a concentration in manganese in the fruit of marrows. The content of total carbohydrates in the fruit of marrows increases with the increase of the concentration of manganese. Increasing the amount of nitrate nitrogen in fertilizers induces a decrease in the amount of the accumulated manganese in fruits. The trend is more clearly expressed in the mixed application.

Blue tetrazolium chloride method [1] could be used as a reagent for determination of micro quantities of manganese in plant samples.

Keywords: blue tetrazolium chloride, fertilization, manganese, cucurbita pepo L. var. giromontia

1. INTRODUCTION)

Optimization of technologies for growing plants is a method to increase plant productivity and to obtain quality yields. Foliar application is considered as part of the agronomic techniques carried out during the period of cultivation as an opportunity to increase plant productivity [2]; [3]; [4] [5]; [6] [7]. In previous our publications there are data about the influence of foliar fertilizers upon the quality of fruit of marrows [8], as well as about the content of Mo in marrows [9]. Marrows are a traditional in Bulgaria early crop grown throughout the country. Interest is due to their excellent flavor and dietary qualities. In this connection it is important to trace the influence of foliar application on some components of the biological value of the fruit. In previous studies [10], and [11] and [12] found correlation between foliar application and qualitative indicators of the yield. ~~Despite the significant number of investigation on vegetables requirements of foliar fertilization, little is known of content of Mn in vegetables and its connection with foliar fertilization. Information in Bulgarian and foreign scientific literature is scanty. In the works of several authors [13], [14], [15], [16], [17], [18] some questions connected with the influence of Mn upon different biochemical processes as well as upon growth of plants are considered.~~

The main aim of this study was to investigate effect of type and method of fertilization on marrows yield and fruit quality. Furthermore, we aimed at clarifying the possibility for using Blue tetrazolium chloride [1] as a reagent for determination of micro quantities of manganese in plant samples.

2. MATERIAL AND METHODS

The investigation was conducted in the period 2007–2009 under open field conditions with marrows (*Cucurbita pepo* L. var. *giromontia*) cultivar Izobilna F₁ on the experimental field of the Agricultural University of Plovdiv, Bulgaria. The soil of the field is classified as Molic Fluvisols [19]. The depth of the humus horizon is 28-30cm. The soil is loamy (clay content from 30% to 41%). Chemically, the soil is characterized by a low content in organic matter (1.46%), pH neutral to slightly alkaline (7.17-7.37) and by the presence of large amounts of CaCO₃, which gives more favorable physical-chemical water and soil properties, despite the heavy mechanical composition. Nitrogen content was low (32-46mg.kg⁻¹), while there was a good stock of soluble phosphorus (P₂O₅ - 16.7-18 mg.kg⁻¹) and potassium (K₂O - 67-96 mg.kg⁻¹).

For the purpose of the experiment three different commercially available complete foliar fertilizers with distinctly different nutrient composition were used: Fitona (7.20%N, 5.20%K₂O, 1.5%Ca 0.9%Mg. 0.1%Fe. 0.1%B, Cu, Zn, Mn, Mo. Fitotech Ltd., Bulgaria),

Comment [P1]: How much Mn?

Hortigrow® (20%N 20%P₂O₅ 20%K₂O, 0.06%Fe, 0.02%Zn, 0.01%Mn, 0.01%Cu, 0.02%B, 0.001%Mo and 1% amino acids, Hortiland Ltd., Nederland), Humustim (on base of potassium humates-3%N, 1.14%P₂O₅, 7.83%K₂O, 3.92%Ca, 1.1%Mg, Cu, Zn, Mo, Mn, Co, B, S. Agrospeis Ltd., Bulgaria).

Comment [P2]: How much Mn?

Soil fertilization was carried out with NPK using a ratio N₁₆P₁₆K₁₆. Phosphorus (Ca(H₂PO₄)₂ - 46% P₂O₅); and potassium (K₂SO₄ - 50% K₂O). fertilizers were applied with last tillage of soil before planting. Nitrogen fertilizer, introduced as NH₄NO₃ (34% N), was applied twice during the growing season. First application was after formation of new leaves of plants, and the second - 20 days after the first.

Water solution of foliar fertilizers was prepared. For the purpose of the experiment were used by the manufacturer recommended concentrations of use. Foliar fertilizers were applied in the given concentrations three times in the phases - beginning of flowering, beginning of fruit production, mass fruit production. Solution with the needed concentration was prepared for the different treatments. Control plants were treated with pure water. The consumption of working solution in the first spraying is 600 l.ha⁻¹, and in the second and third 800 l.ha⁻¹.

Plants were cultivated according to the conventional technology for early field production of marrows, using previously produced seedlings [20]. The seedling was planted after thirty days cultivation in non-heated polythene tunnel. Plants were planted on bed-furrow surface, according to scheme 100+60/50 cm and density of plantation 25000 plants per ha in beginning the May. Growth period was 45 days after planting.

Total carbohydrates were determined using the method of Haygedorn – Jensen [2]. Plant dry matter was determined according to the method of Stanchev et al. [21]. The content of nitrates of fruits was determined whit test method GOST 29270-95 [22]. Manganese was determined in the fruits of marrows [1]. Materials were collected in the phase of mass fruit production

Treatments of the experiment: 1. Control - non fertilized ; 2. Foliar fertilization with 0.3 % Fitona; 3. Foliar fertilization with 0.3 %Hortigrow; 4. Foliar fertilization with 0.3 % Humustim; 5. Soil fertilization with N₁₆P₁₆K₁₆; 6. Soil fertilization with N₁₆P₁₆K₁₆ + 0.3 %Fitona; 7. Soil fertilization with N₁₆P₁₆K₁₆ + 0.3 %Hortigrow ; 8. Soil fertilization with N₁₆P₁₆K₁₆ +0.3 %Humustim;

Determination of manganese (VII) with BTC in plant samples: An analysis for manganese content was carried out using a new extraction-spectrophotometric method with Blue tetrazolium chloride [1]. Manganese (VII) forms an ion-association complex BTC. The molar absorptivity of the ion-association complex is 4.97x10⁴ L mol⁻¹ cm⁻¹ at 255 nm. Beer's law is obeyed in the range of 0.1 – 1.6 µg ml⁻¹. Limit of deterction (DL) is 6.86 ng ml⁻¹

Mn(VII) and limit of quantitation (QL) is 22.8 ng ml^{-1} Mn(VII). The determination was carried out without preliminary separation of manganese. 1g from the plant material was reduced to ashes in an oven in $450 - 500^\circ \text{C}$. The dry residue was dissolved in a dilute hydrochloric acid (1:1) solution. 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. An aliquot of a sample solution was transferred into 100 ml separatory funnel. Add 2 ml of Blue tetrazolium chloride $1 \times 10^{-4} \text{ mol l}^{-1}$, 0.5 ml of sulphuric acid 2 mol l^{-1} . The resulting solution was diluted with distilled water to a total volume of 10 ml. Then 3 ml of 1,2-dichloroethane was added, and the funnels were shaken for 15 s. Transfer the organic layer through a dry filter paper into a 1 cm cuvette and the absorbance measured at 255 nm against a reagent blank using a Spectrophotometer UV-VIS (Germany) [1]. The obtained results are compared with those of the AAS method using a Flame Atomic Absorption Spectrophotometer "Perkin Elmer"(Germany); .

Statistical analysis: The results from the determination of total carbohydrates and dry matter were elaborated using the dispersion analysis method for one factor field trial [23], using the program BIOSTAT (ANOVA). Relative Standard Deviation about Mn was determined according to the BTC method..

3. RESULTS AND DISCUSSION

In the same treatments of fertilization the content of total carbohydrates in the fruit of marrows has been determined. The content of total carbohydrates is the highest in plants receiving soil and foliar fertilization ($\text{N}_{16}\text{P}_{16}\text{K}_{16}$ + Hortigrow). The experimental data (Table 1) show that the content of total carbohydrates is the highest (2.39 %) after mixed fertilization. After only foliar fertilization, the content of total carbohydrates is 0.78%, or three times less than in mixed fertilization. The content of total carbohydrates in the control (non fertilized) is even lower (0.67%). The content of carbohydrates is higher when we used the foliar fertilizer Hortigrow together with the soil fertilization ($\text{N}_{16}\text{P}_{16}\text{K}_{16}$), a result that paralleled that observed for the manganese content in fruits.

TABLE 1. Content of manganese, total carbohydrates and dry matter in the fruit of marrows in foliar and mixed fertilization

Nº	Variants	Mn, mg kg^{-1} BTC method	*RSD BTC method	** Total carbohydrates %	***Dry matter , %	AAS Mn mg kg^{-1}
1	Control - non fertilized	9.67	1.9	0.67	6.02	9.80
2	0.3 % Fitona	8.32	1.5	0.79	6.97	8.00
3	0.3 % Hortigrow	9.70	1.2	0.78	6.18	9.55
4	0.3 % Humustim	8.69	1.7	0.92	6.45	8.80
5	$\text{N}_{16}\text{P}_{16}\text{K}_{16}$	8.48	2.0	1.82	4.80	8.65
6	$\text{N}_{16}\text{P}_{16}\text{K}_{16}$ + 0.3 % Fitona	8.63	1.4	1.34	4.41	8.55
7	$\text{N}_{16}\text{P}_{16}\text{K}_{16}$ + 0.3 % Hortigrow	10.10	1.9	2.39	5.94	10.30
8	$\text{N}_{16}\text{P}_{16}\text{K}_{16}$ + 0.3 % Humustim	8.85	1.7	1.42	5.70	8.67

Comment [P3]: These data (in column three) are presented two times (Table 1 and Table 2). There is no need to present them more than once. Delete them from table two and present the data of table 1 in two different tables (Table 1 with the yield, total carbohydrates and dry matter, Table 2 with the content of Mn by the two different methods)

* Relative Standard Deviation for BTC method (n = 5)

Total carbohydrates % - LSD 0.949, P=0.05 * Dry matter, % - LSD 0.782, P=0.05

The content of dry matter in fruit in the different kinds of fertilization is represented on Table 1. The dry matter in the fruit of marrows is almost the same after fertilization with Fitona, Hortigrow, (Hortigrow + soil fertilization), Humustim, (Humustim + soil fertilization) and control. An exception can be discerned in fertilization with (Fitona + soil fertilization) and soil fertilization N₁₆P₁₆K₁₆.

The change of the dry matter content in the fruits may be due to the increased activity in the production of biomass and their priority allocation to the product portion and in direct connection with the increase in the weight of the fruit. These results are in line with studies of the effect of foliar fertilization on the dynamics of accumulation of dry matter by [24] in fruits of marrows.

The content of microelement manganese in the fruit of marrows after fertilization with foliar (Fitona 0.3%, Hortigrow 0.3 %, Humustim 0.3 %) and mixed fertilization (soil and foliar) is presented on Table 1. The experimental data show that the content of manganese in the fruit of marrows is highest after fertilization with Hortigrow (foliar fertilization and mixed fertilization). This is due to the fact that in the composition of the foliar fertilizer Hortigrow can be found 0.01 % Mn. Similarly Hortigrow comprises amino acids that stimulate growth, development and assimilation of nutritious substances including microelements. The distinction in the content of manganese in the two treatments of fertilization is 0.40 mg.kg⁻¹. Hence, the additional introduction of N, P and K in soil has small influence on the accumulation of manganese in the fruit of marrows.

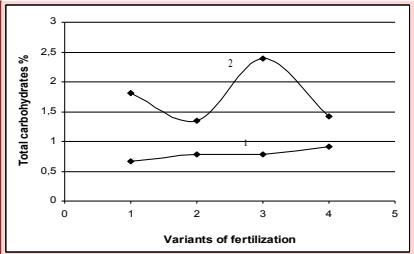
In a recent review, [7] it was stated that the foliar uptake is due to the ability of leaves and stems to absorb the nutritious elements taken in the form of certain solutions. The effect of the foliar nutrition takes place much promptly in comparison to the soil fertilization, which reduces the risks of physiological diseases of plants caused by deficiency or scarcity of a given element [6].

The relationship between the content of total carbohydrates in the fruit of marrows and fertilization is presented on Fig. 1. The experimental data show that the content of total carbohydrates does not change in leaf fertilization, whereas in mixed fertilization their content is higher, as the highest value of total carbohydrates can be read in fertilization with N₁₆P₁₆K₁₆ + Hortigrow. This may be due to the higher percentage content of nitrogen, phosphorus and potassium in the leaf fertilizer Hortigrow. Results are in line with established specificities in the content of total sugars in the fruits of marrows from [25]. They were established that nitrogen and potassium fertilization influence on the content of total sugars. These conclusions are supported by research of [24] and [25]. This all indicates that the

Comment [P4]: It would be better to present the data by using different letters after the mean number and not only the LSD

Comment [P5]: The effect of yield on carbohydrate content should be stressed out along with a possible correlation of Mn and fruit carbohydrates and total yield

nutritious elements N, P and K that have been provided additionally have positive influence on the accumulation of carbohydrates in the fruit of marrows.

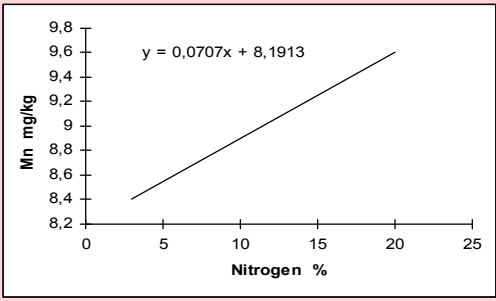


Comment [P6]: Better use bars instead of curves.

Fig. 1 Correlation between the content of carbohydrates in the fruit of marrows and fertilization: 1- Foliar fertilization; 2- Soil and foliar fertilization: Curve 1 – Foliar fertilization: Variants: 1- Control, 2- Fitona, 3- Hortigrow, 4- Humustim; Curve 2 – Soil and foliar fertilization: Variants: 1- Control, 2 - N₁₆P₁₆K₁₆ + Fitona, 3- N₁₆P₁₆K₁₆ + Hortigrow, 4- N₁₆P₁₆K₁₆ + Humustim

In order to characterize the influence of the foliar and mixed fertilizations, we have investigated the influence of nitrogen that was applied by the different fertilizers upon the content of manganese in the fruit of marrows. The experimental data (Fig. 2) show that together with the increase of the percent content of nitrogen in fertilizer, the content of Mn increases to 9.7 mg.kg⁻¹ for 20 % nitrogen in foliar fertilizer. We conclude that the higher content of nitrogen in fertilizers helps for the accumulation of bigger amount of manganese in the fruit of plants.

Comment [P7]: Why control has two different values? I think in curve 2, number 1 is the soil application of N₁₆P₁₆K₁₆ and not control,



Comment [P8]: This could stand only if the Mn concentration in the other two fertilizers was known. Please find out the concentration of Mn in Fitona and Humustim and then discuss on the correlation between nitrogen and Mn

Comment [P9]: Where is the correlation coefficient value? Where are the data points?

Fig. 2. Correlation between the content of Mn in the fruit of marrows and nitrogen in fertilizers;- R² = + 0.877

The influence of fertilization upon nitrate nitrogen (NO₃ - N) in the fruit of marrows is presented on Fig 3. The highest content 250 mg.kg⁻¹ nitrate nitrogen in the fruit can be seen in the leaf fertilizer Hortigrow, as well as in mixed fertilization N₁₆P₁₆K₁₆ + Hortigrow. This can be explained with higher percentage content of nitrogen in the leaf fertilizer Hortigrow.

Comment [P10]: We should know the form in which nitrogen is present in the various fertilizers (i.e. urea, ammonium or nitrate form)

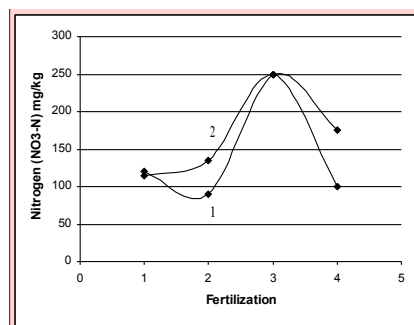


Fig. 3 Correlation between the content of nitrate nitrogen ($\text{NO}_3 - \text{N}$) in the fruit of marrows and fertilization: Curve 1 – Foliar fertilization: Variants: 1- Cotrol, 2- Fitona, 3- Hortigrow, 4- Humustim; Curve 2 – Soil and foliar fertilization: Variants: 1- Cotrol, 2- $\text{N}_{16}\text{P}_{16}\text{K}_{16}$ + Fitona, 3- $\text{N}_{16}\text{P}_{16}\text{K}_{16}$ + Hortigrow, 4- $\text{N}_{16}\text{P}_{16}\text{K}_{16}$ + Humustim

Comment [P11]: If you say correlation then show the correlation coefficient

The interaction between soil and foliar fertilization increased plant productivity. Early and total yield was the highest after soil fertilization with $\text{N}_{16}\text{P}_{16}\text{K}_{16}$ and foliar application with 0.3%Humustim. Therefore appropriate from agronomic and economic point of view is combination of soil fertilization and foliar application of 0.3%Hortigrow and 0.3%Fitona (Table 2.).

Table 2 Subordination between yield and the content of Mn in the fruit of marrows in foliar fertilization and in mixed fertilization (soil and foliar);

№	Variants	Mn, mg kg ⁻¹ BTC method	Yield kg ha ⁻¹
1	Control - non fertilized	9.67	26210
2	0.3 % Fitona	8.32	30840
3	0.3 % Hortigrow	9.70	32430
4	0.3 % Humustim	8.69	39170
5	$\text{N}_{16}\text{P}_{16}\text{K}_{16}$	8.48	38270
6	$\text{N}_{16}\text{P}_{16}\text{K}_{16}$ + 0.3 % Fitona	8.63	39270
7	$\text{N}_{16}\text{P}_{16}\text{K}_{16}$ + 0.3 % Hortigrow	10.10	40840
8	$\text{N}_{16}\text{P}_{16}\text{K}_{16}$ + 0.3 % Humustim	8.85	49450

Yield kg ha⁻¹ - LSD 113.522 P=0.05

Comment [P12]: Make a correlation between yield and carbohydrates as well as between yield and nitrate nitrogen and Mn.

Manganese is an important nutritious element for plants that has an influence on the quality of yield and production. In this respect the influence of manganese upon the yield of marrows in the two kinds of fertilization (foliar fertilization and mixed fertilization) is represented on Table 2. The researches showed that in the control (non fertilized), the content of manganese is lower as in foliar fertilization and also in mixed fertilization. In independent foliar fertilization the highest yield 39170 kg.ha⁻¹ is obtained in the content of

Mn 8.69 mg.kg⁻¹ in the fruit of marrows. In mixed fertilization the highest yield 4945 kg.da⁻¹ is obtained in the content of Mn 8.85 mg.kg⁻¹ in the fruit of marrows. The experimental data show that in mixed fertilization, yield is with 10000 kg.ha⁻¹ higher than that in foliar fertilization. It makes an impression that the content of manganese is almost equal for the two ways of fertilization in which the highest yield is obtained. Consequently the main factor for higher yield is the different fertilization and not the content of manganese.

The influence of the different kind of fertilization upon the yield of fruit is presented on Fig. 4.

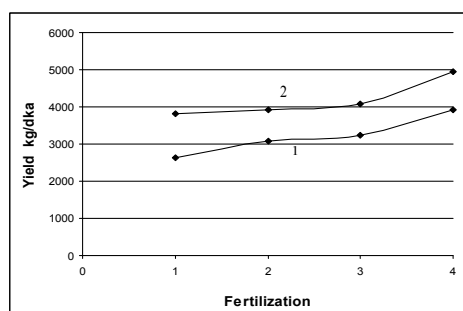


Fig. 4. Subordination between yield from the fruit of marrows and fertilization: *Curve 1 (foliar fertilization):* 1- Control; 2- Fitona; 3- Hortigrow; 4-Humustim; *Curve 2 (mixed fertilization):* 1- N₁₆P₁₆K₁₆ ; 2- N₁₆P₁₆K₁₆ + Fitona ; 3- N₁₆P₁₆K₁₆ + Hortigrow ; 4- N₁₆P₁₆K₁₆ + Humustim

The experimental data show that mixed fertilization (soil and foliar) leads to the increase of yield up to 10000 kg.ha⁻¹ in comparison with foliar fertilization. The highest yield is obtained in fertilization with Humustim (mixed fertilization and foliar fertilization). This may be due to the fact that in the composition of the organic foliar fertilizer Humustim the basic nutritious elements are humic acids that exhibit hormone activity which stimulates growth and development.

The influence of different fertilization upon the content of manganese in the fruit of marrows is presented on Fig.5. The experimental data show that the highest content of Mn can be seen in foliar fertilization with Hortigrow and mixed fertilization N₁₆P₁₆K₁₆ + Hortigrow. This may be due to the fact that Hortigrow comprises a higher percentage Mn in comparison with the other foliar fertilization.

Comment [P13]: Not only the different fertilization but the different nutrient amount applied, based on the great differences between fertilizer composition.

Comment [P14]: These have been written above

Comment [P15]: Again, how much Mn do the other fertilizers have?

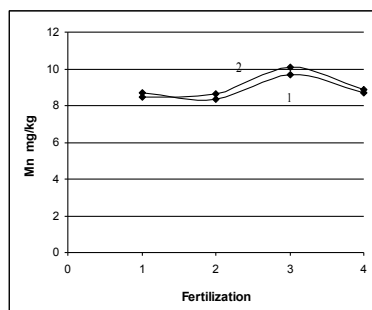


Fig. 5 Correlation between the content of manganese in the fruit of marrows and fertilization: Curve 1 – Foliar fertilization: Variants: 1- Cotrol, 2- Fitona, 3- Hortigrow, 4- Humustim; Curve 2 – Soil and foliar fertilization: Variants: 1- Cotrol, 2- $N_{16}P_{16}K_{16}$ + Fitona, 3- $N_{16}P_{16}K_{16}$ + Hortigrow, 4- $N_{16}P_{16}K_{16}$ + Humustim

4. CONCLUSION

The results show that application of foliar fertilizers Fitona, Hortigrow and Humustim and increased yields of zucchini in preserved and improved product quality, the dry matter, total sugars and content of nitrates in fruits. The effect occurred more strongly when it was applied on a background of soil fertilization.

The use of foliar fertilizers containing different macro- and micronutrients in the period of growing marrows influenced on the content of Mn in their fruit. The highest content of Mn in the fruits of zucchini was found after combined soil and foliar fertilization with 0.3% Hortigrow. The decrease in yield induces a concentration in manganese in the fruit of marrows. The content of total carbohydrates in the fruit of marrows increases with the increase of the concentration of manganese. Increasing the amount of nitrate nitrogen in fertilizers induces a decrease in the amount of the accumulated manganese in fruits. The trend is more clearly expressed in the mixed application.

Blue tetrazolium chloride method [1] could be used as a reagent for determination of micro quantities of manganese in plant samples.

ACKNOWLEDGEMENTS

The authors would like to thank the Research Fund of the Agricultural University for financial support.

REFERENCES

[1] Kostova D, Mehandjiev D. Determination of manganese(VII) as 3,3'-dianisole-4,4'-bis (3,5 – diphenyltetrazolium chloride) complex and its application, *Russian Journal of Inorganic Chemistry*, 2013, vol. 58, N 3, 293-299,

Comment [P16]: Zucchini or marrow, retain the same name within the entire text

Comment [P17]: This is over-simplified. You can not be sure that Mn did that and not N which was 7 times higher in Hortigrow compared to Humustim!!

[2] Panayotov, N.. Morphological development and productivity of pepper plants after application of foliar fertilizer Hortigow. Scientific researches on the Union of Scientists in Bulgaria-Plovdiv, Series B "Technique and Technology," Scientific session "Technology, Agricultural Sciences and Technology" 2004, vol.III, pp 97-104. Bulgarian.

[3] Panayotov, N. Morphological behaviors and productivity of pepper plants under influence of foliar fertilizer Kristalon. Analele Universitii "Valahia" Targoviste. Facilia VI "Tehnologia produselor alimentare, pescuit si acvacultura". 2005 The annals of "Valahia" University of Targoviste, Fascicle VI "Food technology, aquaculture and fishing", pp, 24-30.

[4] Bileva T, Babrikov T. Study the influence of Humustim on onion varieties from genus *Allium cepa* growed on open field in infested with *Ditylenchus dipsaci* soil. Proceedings of Scientific conference for students, PhD students and young scientists "Five years Federation of Education & Science" Technical University, Plovdiv, 2007vol. 1: Medico-biological science, pp. 188 - 192. Bulgarian.

[5] Al-Humrani Y. Study the effect of complex fertilizers on nutrition, growth and productivity of radish (*Raphanus sativus* var. *Radicula* - Pers), 2009, Thesis, Bulgarian.

[6] Fageria NK, Barbosa - Filho MP, Moreira A., Gumaraes C M.. Foliar Fertilization of Crop plants, Journal of plant nutrition, 2009, Apr- June. 32 (4-6) pp. 1044-1064.

[7] Fernandez V, Eichert T. Uptake of hydrophilic solutes through plant leaves: current state of knowledge and perspectives of foliar fertilization, Critical Reviews in Plant Sciences, 2009, v. 28. 183 182, pp. 36-68.

[8] Haytova D. Quality of the fruits of Zucchini Squash in the Application of Foliar Fertilizers, Ecology and future, 2013, vol.XII, №1, pp.28-32. Bulgarian.

[9] Haytova D, Kostova D. Determination of molybdenum in the fruit of marrows (*Cucurbita pepo* var. *giromontia*), *University of Food Technologies – Plovdiv, Scientific Works*, 2011, Vol. LVIII, Issue 1, 492-496 Bulgarian.

[10] Doykova M, Rankov V. Studying the effectiveness of foliar application with Laktofol for zucchini. Second Scientific-Practical Conference "Ecological problems of agriculture" Agro-Eko '95, , Scientific works of VSI, 1995.vol. XL, No 3, pp. 247-250, Bulgarian.

[11] Doykova M, Rankov V., More on the subject of foliar application of zucchini. Three scientific-practical conference "Environmental Problems of Agriculture" Agro-Eko '97, Scientific Works of VSI, 1997, Vol.XLII No.2, pp. 47-49, Bulgarian.

[12] Doykova M, Rankov V. Foliar feeding of zucchini - possibility to reduce fertilization with mineral fertilizers. Collection of reports - Fourth scientific conference with international participation "Ecology and Health` 2002, pp 105-108, Bulgarian.

- [13] Kamburova M, Panayotov N.: Extraction-spectrophotometric determination of molybdenum in vegetable crops, *Scientific Works VSI*, 1996, vol. XLI, 79-87, Bulgarian.
- [14] Humpries J, Stangoulis J, Graham R: Manganese. In: A. Barker, D. Pilbeam, *Handbook of Plant Nutrition*, 2007, Taylor and Francis, USA, pp. 351-366.
- [15] Li B, Zhou DM, Cang L, Zhang HL, Fan XH, Qin SW: Soil micronutrient availability to crops as affected by long-term inorganic and organic fertilizer applications, *Soil & Tillage Research*, 2007, 96, 166-173.
- [16] Paivi EH, Reinivuori P, Mattilä H, Pakkalainen J, Koponen A, Happonen J, Hellström E, Ovaskainen M. Changes in the mineral and trace element contents of cereals, fruits and vegetables in Finland, *Journal of Food Composition and Analysis*, 2007, 20, 487-495.
- [17] Silber A., et al. Manganese nutrition of pepper: Growth, Mn uptake and fruit disorder incidence, *Scientia Horticulturae* 2009., 123, 197-203.
- [18] Millaleo R, Reyes-Díaz M, Ivanov A.G, Mora ML, Alberdi M. Manganese as essential and toxic element for plants: transport, accumulation and resistance mechanisms, *J. Soil Sci. Plant Nutr.* 2010, 10(4):476-494 ().
- [19] Popova R, Sevov A, Soli characteristic of experimental field of crop production department as result of cultivation of grain. technical and forage crops. Agricultural University of Plovdiv, Scientific works, 2010, vol. LV, book 1, pp. 151-156, Bulgarian.
- [20] Cholakov D. Technology for cultivation of marrows in vegetable-growing, *Academic publishers of Agricultural University - Plovdiv*, 2009, pp. 150-151, Bulgarian.
- [21] Stanchev L., Gurov G, Mashev N. Manual for chemical analysis of plants, soils and fertilizers, 1968, publisher "Hr. G. Danov", Plovdiv, p. 287, Bulgarian.
- [22] GOST 29270-95 Fruit and vegetable products. Methods for determination of nitrates <http://www.gosthelp.ru/gost/gost9240.html>, Russian
- [23] Dimova D., E. Marinkov: Experimental work and biometry, *Academic publishers of Agricultural University*, 1999, Plovdiv, Bulgarian.
- [24] Irannejad RS, Rezadust S, Rushdi, M. Evaluation of biological fertilizers potential for providing nitrogen need in pumpkin (*Cucurbita pepo* L.). *Middle-East Journal of Scientific Research*, 2011, 8(5): 873-879.
- [25] Sedano-Castro G et al. Rendimiento y calidad de frutos de calabacita con altas dosis de N y K. *Terra latinoamericana*, 2011, vol. 29, №2, 133-142.

APPENDIX