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Изворен научен труд

Fe, Mn, Cu AND Zn CONTENT IN PLANT ORGANS OF THE ORIENTAL AND VIRGINIA TOBACCO

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INTRODUCTION

Mineral elements have a direct effect on tobacco combustibility. They affect the ability of the product to smolder (and not burn with fire) while catalyzing burning of the organic compounds. When an appropriate ratio of different elements is achieved the tobacco has good burning rate, characterized by uniform and sufficiently intensive smoldering. This provides for the expression of the smoking potential that is carried by the organic compounds (Gyuzelev, 1983).

Microelements affect mainly biochemical processes in tobacco plants during vegetation. Fe deficiency can cause spot formation and development of so called "grey tobacco" in Virginia types. Mn deficiency leads to formation of chlorotic spots, necrosis in young leaves and turgor reduction.

Physiologo-biochemical function of Cu is connected to the most intricate and complex processes in plant cells: respiration, photosynthesis, protein and carbohydrate synthesis, nitrogen and phosphorus metabolism etc. Zn plays polyfunctional role in plant metabolism, too. It affects directly or indirectly respiration, photosynthesis, chlorophyll biosynthesis, metabolism of phosphorus, nitrogen and carbohydrates.

In high concentrations Fe, Mn, Cu and Zn could be toxic and cause physiological disturbances in tobacco plant. In addition this could result in negative effects on the quality of the dried tobacco.

The main source of these elements for tobacco is the soil. Soil characteristics play important role in their mobility and availability to the plant – ðÍ, humus content, mechanical composition etc. (Adamu et al., 1989; Xian and Shokonifard, 1989; King and Hajjar, 1990; Bell et al., 1992; Khan et al., 1992).

Foreign literature contains data about the upper and lower limits for some macro- and microelements in leaves, which are specific for different tobacco types (mostly Virginia and Burley) and plant development stages (Tso, 1972; Jones et al., 1991; Fischer, 1992; Campbell, 2000). In Bulgaria such studies on the desired chemical composition as criteria for nutritive element's sufficiency and high yield and quality of the dried tobacco are scarce and are only available about the macroelements (Ìitreva and Apostolova, 1986).

The aim of the present study was to evaluate the accumulation in different organs of the plants in two types of tobacco – Oriental and Virginia – of microelements (Fe, Mn, Cu, Zn), important for plant growth and development as well as for the quality of the dried tobacco.

MATERIAL AND METHODS

The study was performed on rendzina soil with oriental tobacco and on alluvial meadow soil with Virginia tobacco in stationary experiments. Both soils have basic soil reaction (table 1). The rendzina soil has average humus content and heavy sandy-clay mechanical composition, while the alluvial meadow soil has low humus content and lighter mechanical composition.

Table 1. Soil characteristics
Табела 1 Карактеристика на почвата

Soil - Почва	pH	Humus content, % Содржина на хумус	Clay content, % Содржина на глина
Rendzina - Рендзина	8.24	2.78	47.3
Alluvial meadow Алувијално - ливадска	8.43	1.51	23.5

Total microelement content in the soil was determined according to BDS ISO 14869-1, which includes initial heat treatment and degradation with HF, $HClO_4$ and HNO_3 acids. Extraction of the soluble forms of Fe, Mn, Cu and Zn from the soil was done with 0.005M DTPA + 0.1M TEA solution, pH 7.3.

Tobacco varieties Plovdiv 7 (Oriental) and 0454 (Virginia type) were studied. The main agricultural practices - plant density, weeding, irrigation and fertilization - were in accordance with the typical ones for the respective types and varieties of tobacco.

Leaves from the first, middle and upper priming were harvested for analysis at full maturity and stems and inflorescences - at the end of the vegetation period. Samples were prepared for Fe, Mn, Cu and Zn determination çthrough dry burning and dissolving in 3 M HCl.

The content of microelements in soil and plant samples was determined with atomic absorption spectrometer "Spektra AA 220" (Varian, Australia) using the following wavelengths: Fe - 248.3 nm, Mn - 279.5 nm, Cè - 324.8 nm, Zn - 213.9 nm.

RESULTS AND DISCUSSION

Soils

Table 2 presents data on the total content of Fe, Mn, Cu, and Zn in the soils. Alluvial meadow soil has higher Fe content as compared to rendzina. The total Mn content in both soils is lower than the average for Bulgaria, which varies between 880 mg/kg (Brashnarova, 1981). The total Cu and Zn content in both soils is rather high, but according to the Bulgarian standards is below the MAC (maximum allowable content) for the corresponding ðÍ (State gazette, 39, 2002).

Table 2. Soil content of the nutrition elements
Табела 2 Содржина на хранливи елементи во почвата

Soil - Почва	Total content, mg/kg Вкупна количина				Available content, mg/kg Достапна количина			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
Rendzina - Рендзина	29700	651.6	163.9	90.2	4.98	22.5	13.0	11.0
Alluvial meadow Алувијално - ливадска	45700	613.0	208.6	88.4	9.10	18.2	16.0	8.88

Iron extractable by DTPA at pH 7.3 is rather low in both soils due to the basic soil reaction where the alluvial meadow soil content was higher (table 2).

According to MAFF classification (Mitsios et al., 2005), extractable Mn is sufficient in both soils. Zn and Cu content represent high reserves, which does not correspond with the basic reaction and is most probably due to industrial pollution.

Tobacco

Iron

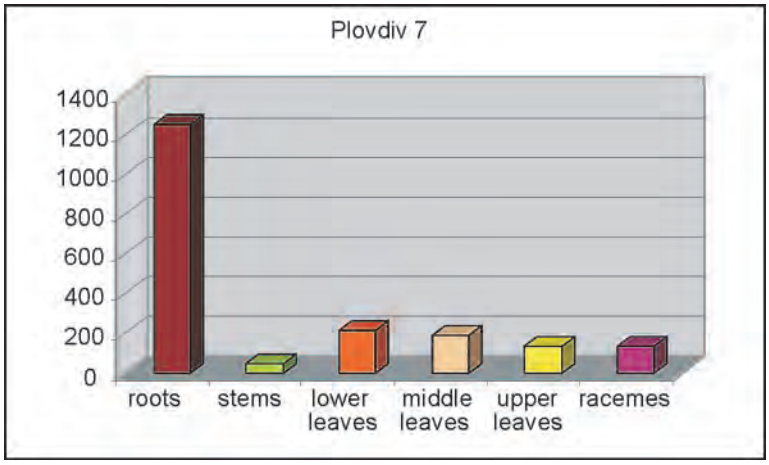

Figure 1. Fe content in plant organs of oriental tobacco (Plovdiv 7)

Слика 1 Содржина на железо во растителните органи на ориенталскиот тутун (Пловдив 7)

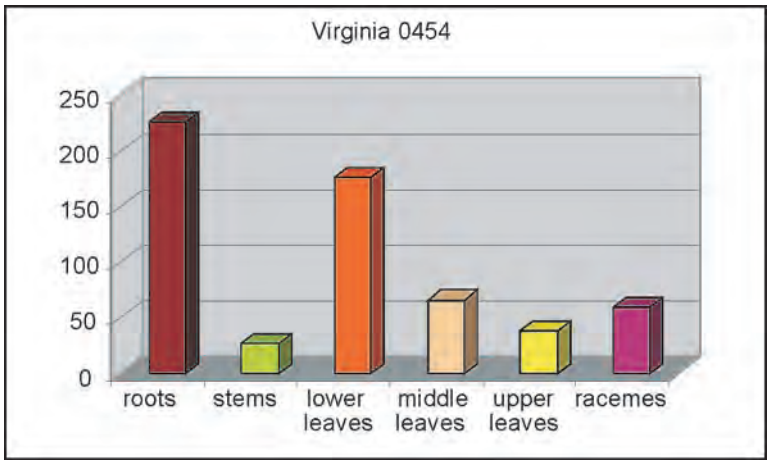

Figure 2. Fe content in above-ground parts of Virginia tobacco

Слика 2 Содржина на железо во надземните делови на вирџинискиот тутун

According to the literature the optimum Fe content in tobacco leaves is from 50 to 300 mg/kg (Campbell, 2000). For the experimental conditions the measured concentrations in mature leaves of oriental tobacco are within these limits in spite of the basic reaction and low soil reserves of extractable Fe (fig.1, 2). In Virginia tobacco Fe content is lower, falling below 50 mg/kg for the last priming.

Following the distribution of Fe in different plant parts reveals that it is lowest in the stems of both tobacco types. Most Fe is accumulated in the roots. This is especially pronounced in oriental tobacco. Leaves from first, second and third priming follow. In spite of the low mobility of Fe within the plant (80-90% of the element are fixed in organic structures), the inflorescences accumulate higher quantities of the element than the last priming. One possible reason is that the period of bud formation and flowering is characterized by high consumption of Zn, Fe and Cu.

Manganese

According to Jones et al. (1991) Mn content in tobacco leaves varies depending on the plant stage from 20 to 400 mg/kg. Some references point of higher levels of the element in the leaves – up to 700 mg/kg (Tso, 1972). Data of Bell et al. (1992) demonstrated sharp increase of Mn in acid soil reaction where it can reach 2400 mg/kg and more. The concentrations of Mn in the leaves of both oriental and Virginia tobaccos are much lower in our study due to the basic soil reaction and rather low soil reserves of this element (fig. 3, 4).

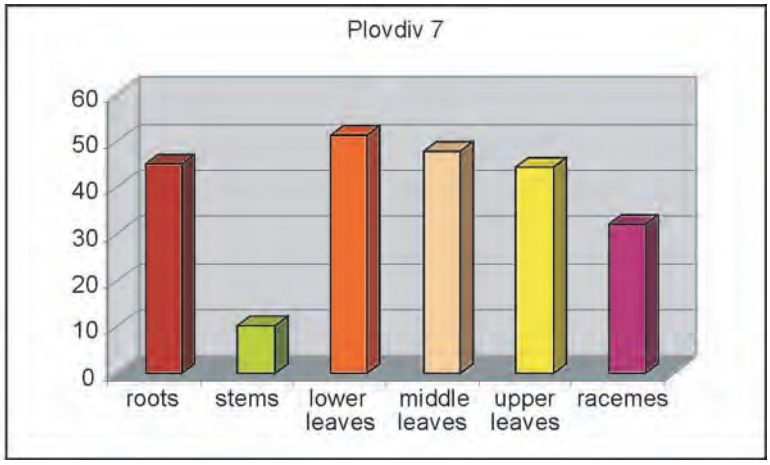

Figure 3. Mn content in plant organs of oriental tobacco (Plovdiv 7)
Слика 3 Содржина на манган во растителните органи на ориенталскиот тутун (Пловдив 7)

Similarly to Fe Mn content is lowest in the stems. Leaf content is 5-6 times higher. Measured Mn content in the three primings in both tobacco types is similar, with no significant differences. In the inflorescences Mn content gradually decreases. This tendency could be observed in both oriental and Virginia tobaccos.

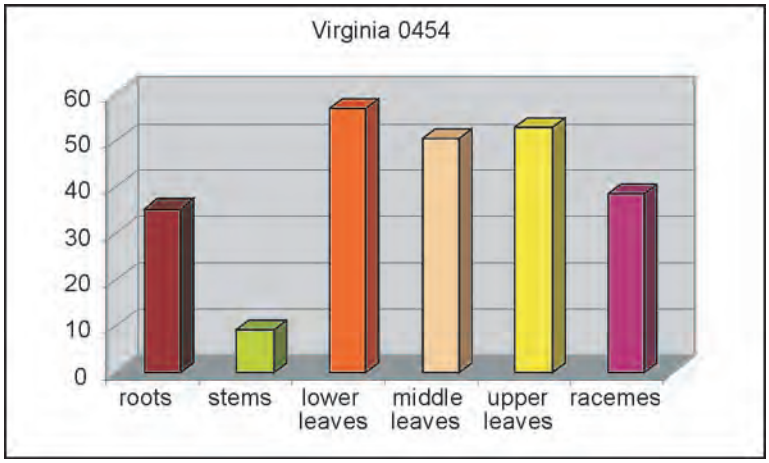

Figure 4. Mn content in plant parts of Virginia tobacco
Слика 4 Содржина на манган во растителните органи на вирџинискиот тутун

Copper

In contrast to the high Cu content in the soil the concentration of the element in the leaves of Plovdiv 7 variety (oriental tobacco) is between 11.9 and 13.3, while in Virginia 0454 it is between 15.5 mg/kg and 18.3 mg/kg. According to Êàbata Pendias and Pendias (1984), the normal concentration of Cu in plants varies between 5 and 30 mg/kg. The lower toxicity level for most crops determined by these authors is 20 mg/kg.

Both tobacco types accumulate most of the element in the roots, while the content in the stems is lowest. In contrast to the known low element mobility in the plant Cu can be found in high concentrations in the inflorescences – very close to the one in the roots (fig. 5, 6). The element distribution in the primings in Virginia tobacco shows a tendency for increasing from first to the last priming, while in the oriental tobacco the concentration is highest in the second priming.

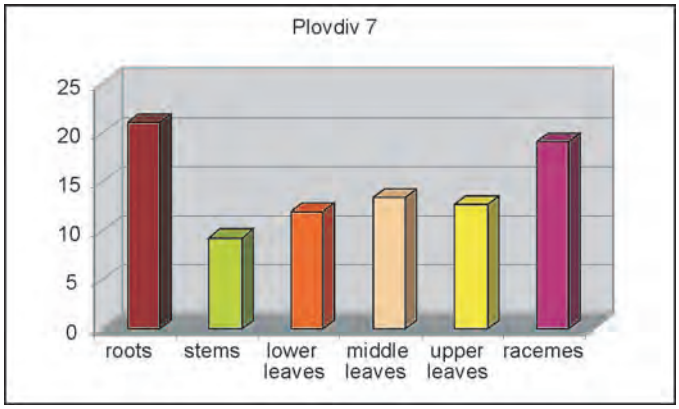

Figure 5. Cu content in plant organs of oriental tobacco (Plovdiv 7)
Слика 5 Содржина на бакар во растителните органи на ориенталскиот тутун (Пловдив 7)

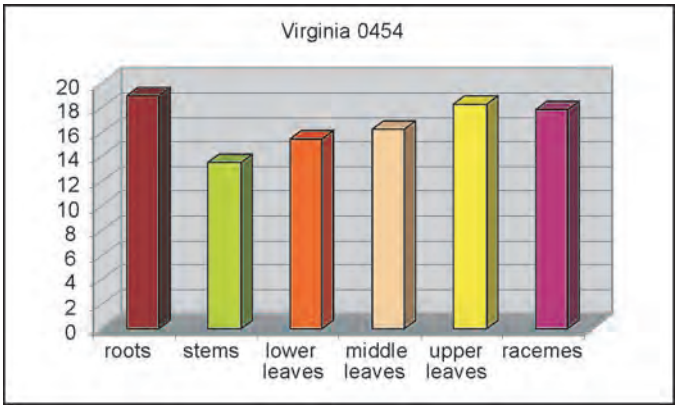

Figure 6. Cu content in plant organs of Virginia tobacco
Слика 6 Содржина на бакар во растителните органи на вирџинискиот тутун

Zinc

When leaf diagnostics is attempted the leaves of plants that suffer Zn deficiency are presumed to contain less than 20 mg Zn per 1 kg dry matter, the normal quantity is within 20-80 mg, and the excess - above 100-400 mg.

The concentration of Zn in the leaves of oriental tobacco is between 51 and 63 mg/kg, while in Virginia 0454 it is from 50.8 to 55.4 mg/kg. This data corresponds to findings of other authors (Tso, 1972; Fischer, 1992; Pelivanoska, 2007) and are within the norm in spite of the high element content in the soils.

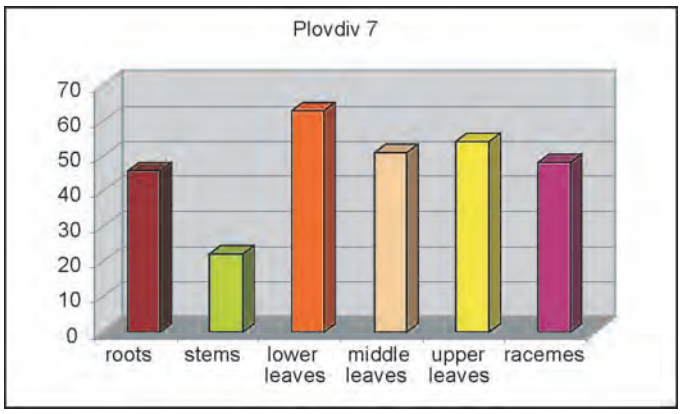

Figure 7. Zn content in plant organs of oriental tobacco (Plovdiv 7)
Слика 7 Содржина на цинк во растителните органи на ориенталскиот тутун (Пловдив 7)

Both tobacco types accumulate most Zn in the leaves where in V 0454 variety a slight tendency for increasing from first to the last priming can be observed. The concentration of the element in the inflorescences is similar to the one in the leaves, while stems and roots contain relatively less Zn.

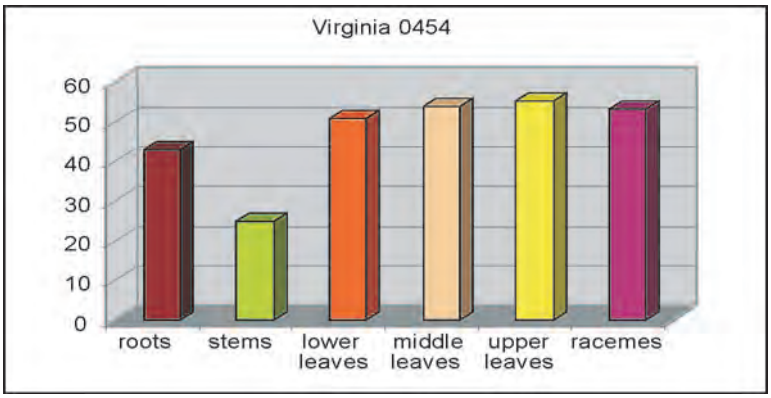

Figure 8. Zn content in plant organs of Virginia tobacco
Слика 8 Содржина на цинк во растителните органи на вирџинискиот тутун

CONCLUSION

Both tobacco types accumulate Fe, Mn, Zn and Cu in a similar manner in different organs:

1. Fe content is highest in the roots and lowest in the stems. A strong tendency was observed for decreasing element concentration in the leaves from first to the last priming.

2. Mn content is highest in the leaves and lowest in the stems. Values within the mature leaves from the three primings are similar.

3. Cu concentration is highest in the roots and lowest in the stems. In the inflorescences the element concentration is high – close to the on in the roots.

4. Zn content is highest in the leaves. Element concentration in the inflorescences is close to the one in the leaves, while in the roots and the stems it is relatively lower.

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СОДРЖИНА НА Fe, Mn, Cu И Zn ВО РАСТИТЕЛНИТЕ ОРГАНИ НА ОРИЕНТАЛСКИТЕ И ВИРЏИНИСКИТЕ ТУТУНИ

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РЕЗИМЕ

Испитувана е акумулацијата на железо, манган, бакар и цинк во различни органи на тутунските растенија од два типови тутун - ориенталски и вирџиниски. Мерена е вкупната содржина на Fe, Mn, Cu и Zn преку разложување со HF, $HClO_4$ и HNO_3 киселина. Се користи раствор од 0.0055M DTPA + 0.1M TEA, со pH 7.3, за екстракција на мобилните форми на елементите од почвите. Подготовката на растителните проби се врши со помош на суво спалување растворање во 3 M HCl. За одредување на содржината на Fe, Mn, Cu и Zn во почвата и растителните проби користен е атомски апсорпционен спектрометар Varian Spektra AA 220. Одредена е сличноста помеѓу содржините на овие елементи во растителните органи на двата типа тутун. Содржината на железо е највисока во корените, а најниска во стеблата. Забележана е силна тенденција кон опаѓање на концентрацијата на испитуваните елементи во лисјата од првата до последната берба. Највисока содржина на манган има во лисјата, а најниска во стеблата. Кај соцветијата овој елемент има висока содржина - слична на онаа во коренот. Содржината на цинк е највисока во лисјата. Концентрацијата на овој елемент во соцветијата е слична со онаа во лисјата, но е пониска отколку во корените и стеблата.

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