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INFLUENCE OF SOME SOIL PARAMETERS ON Cu AND Zn CONTENTS IN THE ORIENTAL TOBACOO

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ABSTRACT

Concentration of metals in soils is associated with biological and geochemical cycles as well as with the anthropogenic influence, such as agricultural and industrial activities, transport, and waste management. Tobacco can easily accumulate heavy metals in leaves. The objectives of this study were to determine Cu and Zn concentrations in tobacco leaves produced in different growing areas in Macedonia as well as to determine the most important soil parameters (chemical and physical), which influence the concentration of the above-mentioned metals in Oriental tobacco leaves.

The concentration of heavy metals in tobacco is influenced by many factors, such as: soil type, reaction pH, stalk position, application of metal containing pesticides, soil treatment, fertilization and priming. For that purpose, 50 soil samples were taken from different locations in Macedonia, i.e. family farms that grow Oriental tobacco. A correlation was made between soil parameters and concentration of Cu and Zn in the lower, middle and upper primings of tobacco stalk. The study showed a strong correlation between concentrations of the two investigated metals in these three primings. It also showed that the accumulation of these metals in tobacco leaves was not influenced by their content in soil. The Cu and Zn concentrations in the investigated soils and in tobacco were below permissible limit.

Key words: Cu, Zn, correlation, soil parameters, tobacco

ВЛИЈАНИЕ НА НЕКОИ ПОЧВЕНИ ПАРАМЕТРИ ВРЗ СОДРЖИНАТА НА Cu И Zn ВО ОРИЕНТАЛСКИОТ ТУТУН

Концентрациите на металите во почвата се поврзани со геохемиските и биолошките, циклуси, како и антропогените влијанија, пред сé индустриските и земјоделските активности, транспортот и управувањето со отпадот. Тутунот лесно може да акумулира некои тешки метали во своите листови. Цели на оваа студија беа одредувања на концентрациите на бакар и цинк во листовите ориенталски тутун произведен во различни производни реони од Македонија, како и утврдување на влијанието на поважните почвени (хемиски и физички) параметри врз концентрацијата на истите. Содржината на тешките метали во тутунот е под влијание на многу фактори меѓу кои: типот на почвата, почвената реакција, примената на пестициди кои содржат метали, како и од третирањето на почвата, вклучувајќи ги ѓубриња та и бербениот појас. За реализација на поставените цели беа земени 50 почвени примероци од различни локации во Македонија, семејни фарми кои одгледуваат ориенталски тутун. Направена е корелација меѓу почвените параметри и вкупната концентрација на Cu и Zn од трите бербени појаси (долен, среден и горен) на тутунското стебло. Добиените резултати покажуваат дека постои

силна корелација меѓу концентрациите на двата испитувани метали во трите појаси и дека акумулацијата на овие метали во тутунските листови не е под влијание на нивната содржина во почвата. Концентрација на Cu и Zn во испитуваните почви и тутун е под дозволените граници.

Клучни зборови: Cu, Zn, корелација, почвени параметри, тутун

INTRODUCTION

In the group of agricultural products, tobacco plays a significant role in the agricultural production of the Republic of Macedonia. The export of agricultural products, besides wine, grapes, fruit and some early garden crops, consists mostly of tobacco and tobacco products. The specific climate and soil conditions in Macedonia are suitable for growing Oriental tobacco.

Specific physicochemical characteristics make the Macedonian tobacco an irreplaceable component of the blend used in large number of the World's famous cigarettes brands . Copper and zinc concentrations in soil are affected by a large number of processes contributing to their released amounts, transport, and creating different complex compounds. This study shows the correlation between certain basic soil characteristics and the overall Cu and Zn concentration in the three primings of the Oriental tobacco grown in various parts of Macedonia.

It is well known that micronutrients such as iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) are essential metals for plant growth and yield. Higher concentrations of these elements can infiltrate into the food chain, becoming increasingly dangerous **to** humans and wildlife. Zn and Cu are enzyme activators. Application of fungicides containing zinc and some mineral waste can also increase the concentration of zinc in soils. Besides Zn, Cu is also an enzyme activator and is involved in chlorophyll formation (Tucker, 1999)**.**

Soil reaction is one of the major factors influencing the metal concentration in tobacco leaves (Adamu, 1989, Sanders et al. 1986; Anderson et al. 1988, Golia et al.2001, Zaprijanova et al, 2010). A significant negative correlation between pH of soil and heavy metal content in oriental tobacco was determined in Golia's studies et al. 2007. Husnjak et al., 2009, stated the same, indicating that heavy metal content in tobacco is influenced individually, or interactively by several parameters such as soil reaction (pH), organic matter content (humus), mechanical content (percentage of clay), etc. Adamu et al., 1989, and Zaprijanova et al., 2010, found that humus content influences the heavy metal concentration, especially that of Pb and Cd.

MATERIALS AND METHODS

50 composite soil samples were collected from pedological profiles at fixed depths of; 0 - 10 cm, 10 – 20 and 20-30 cm. Two samples from each locality were taken during November, 2010. The same localities were also used for sampling dry tobacco from the lower, middle and upper primings. The lower primings included the sand and bottom leaves. The middle primings included the first, second and third middle leaves. In the upper primings were lower top and top leaves. Samples were taken from family farms in the well-known tobacco-growing regions in Macedonia (Prilep, Krivogashtani, Mogila, Novaci, Bitola, Demir Hisar, Krushevo, Dolneni, Veles, Cashka, Studenicani) and in some regions of Eastern Macedonia (Strumica, Vasilevo, Bosilevo, Novo Selo, Radovish and Konce). Sampling was made in accordance with ISO 11464:2006. First they were air-dried, and after that crushed and sieved through a 2-mm sieve. Physical properties were determined such as; clay content (Korunović & S.V. Stojanović, 1989), pH (10390:2005), total nitrogen (modified Kjeldahl method-ISO 11361:1995), humus (standard method developed by I.V. Tjurin, modified by Simakov), available phosphorus and potassium (Al-method, validated at the Scientific Tobacco Institute - Prilep, Macedonia, 2009). The total concentration of metals was determined using the Aqua Regia (HCl-HNO_3, 3:1) extraction

method (ISO 11047:1998) after digestion at 180ºC for 2 h. All reagents were of analytical grade (Merck, Germany). Appropriate blanks were included in all extractions. The data were statistically analyzed using correlation analysis (Pearson correlation, two-tailed). Results from two replicates were averaged prior to statistical analyses. Statistical analyses were performed using the SPSS 9.0 software. Correlation analysis was used to establish a relationship between physical and chemical characteristics of soil samples and the heavy metals content in the Oriental tobacco leaf samples from the three positions in the plant.

RESULTS AND DISCUSSION

The analysis of soil composition shows a high variation of the major physical and chemical properties which define soil fertility (Table 1). The clay content varied from 19.50 to 77.6% and pH ranged from 6.00-8.50. According to the results, 54% of the samples showed low humus content, 42% were with average content and 4% with very low and good content. The total nitrogen content was low and similar to that of the humus. The reaction of soil (pH) was neutral in 58% of the soils, 16% were weakly acid and 20% of the samples had poorly to moderately alkaline reaction. 80% of the soils were non-carbonate, 6% were poorly carbonate, 8% moderately and 6% strongly carbonate. 36% of the samples had low and extremely low concentration of phosphorus. The available phosphorus and potassium concentrations varied from 1.54 to 17.96 mg/100g and 3.18- 22.96 mg/100g soil, respectively.

Table 1. Basic soil properties, descriptive statistics

Statistical index	Humus %	Total Nitrogen %	Soil reaction (pH)		Clay %	mg/100 g soil	
			H_2O	(pH) KCl		P_20_5	K_2O
Mean	1.64	0.08	6.97	5.82	39.41	17.96	22.96
Minimum	0.77	0.01	6.00	4.84	19.50	1.54	3.18
Maximum	3.21	0.40	8.50	7.23	77.60	73.77	60.93
CV, %	33.14	66.92	8.63	10.29	31.50	102.66	34.66

The Cu content in the examined soils ranges from 1 to 20 mg/kg . Zn concentration varied from 2 to 34.10 mg/kg (Table 2).

Table 2. Content of Cu and Zn in tobacco and soil (n=50)

Elements	Statistical index	Tobacco			Soil Depth (cm)		
		Lower primings	Middle primings	Upper primings	0-10	10-20	20-30
Cu mg/kg	Mean	5.25	6.12	5.46	17.69	17.75	17.81
	Minimum	1.95	1.35	1.90	5.10	6.17	6.33
	Maximum	15.85	13.00	10.25	45.07	44.27	41.57
	CV, %	51.24	47.86	36.88	50.47	50.84	48.73
Zn mg/kg	Mean	13.67	20.98	18.51	43.24	46.04	49.60
	Minimum	2.19	4.58	6.37	15.53	15.68	17.53
	Maximum	34.10	210.50	185.25	81.76	117.61	127.75
	CV, %	44.22	136.60	134.78	40.19	49.03	44.68

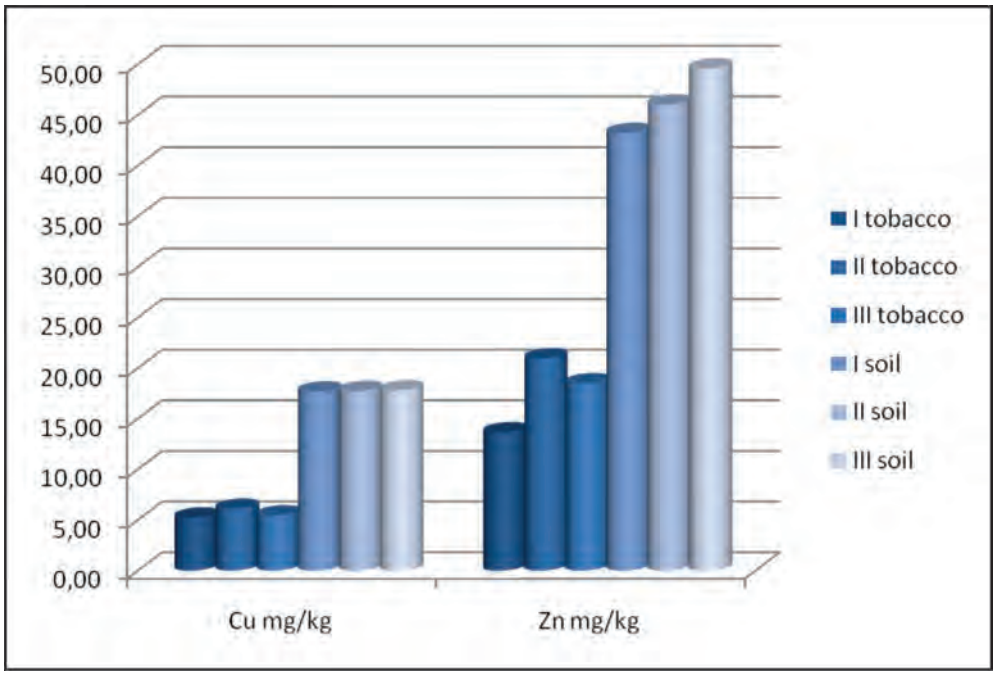

Figure 1. Average concentrations of Cu and Zn in dry soils and tobacco

The average concentrations od Cu and Zn in tobacco and soil samples (Figure 1) indicate that soil has higher concentrations of metal compared to tobacco. Both elements had higer concentrations in the second priming of raw tobacco samples. Cu content in soil had a steady distribution in all three layers (0-10, 10-20 and 20-30 cm), while Zn concentration was higher in the IInd and the IIIrd layer.

Table 3. Correlation between soil parameters and the concentration of Cu and Zn in Oriental tobacco (n = 50)

Parameter	Cu 1st	Cu 2nd	Cu 3^{d}	Zn 1st	Zn 2nd	Zn 3rd
Clay %	0.279*	0.026	0.001	0.323*	0.173	-0.212
pH	0.039	0.047	0.112	-0.060	0.079	-0.140
Cu 1st		0.540*	-0.041**	0.153	0.191	-0.059
Cu 2nd			0.497**	0.202	0.137	0.211
Cu 3^{d}				0.003	0.109	0.126
Zn1st					-0.050	-0.036
Zn 2nd						0.091
Zn 3^{d}						

1st - lower primings 2nd – middle primings 3rd – upper primings

*.Correlation is significant at 0.05 level (2-tailed).
**.Correlation is significant at 0.01 level (2-tailed)

Descriptive statistics for Cu and Zn contents in soils and tobacco leaves from the studied area is presented in Table 2. Higher concentrations of Zn and Cu were recorded in the second primings. Correlation coefficients between total metal concentrations in tobacco and soil parameters (Table 3) showed a strong relationship among the concentrations of each

tobacco priming (lower, middle and upper). Cu had a significant correlation at 0.01 level, which was not the case with Zn. Clay had a poor influence (correlation is significant at 0.05 level) on the concentration of Cu, and Zn in the first priming of Oriental tobacco. No significant correlation was noticed between reaction pH and metal contents in our investigations, which does not coincide with those of some authors, who reported strong correlation (Adamu et al., 1989; Golia et al. 2007, Zapryanova, 2010).

CONCLUSION

According to the results, it can be stated that most of the soils are ideal for producing high quality Oriental tobacco. Concentrations of Cu and Zn in investigated tobacco plants and soils in R. Macedonia are below permissible limit values in conventional and ecological agriculture. Comparing the results of the investigation, it can be concluded that heavy metal content in soil has a negligible or no influence upon the heavy metal content in tobacco.

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