UDC 633.71
Тутун/Tobacco, Vol.59, N° 1-2, 13-17, 2009
Институт за тутун - Прилеп, Р. Македонија

ISSN 0494-3244
UDC: 633.71:546.4/.8(497.5)
Original Scientific Paper

HEAVY METAL CONTENT IN SOIL AND IN TOBACCO LEAF IN CROATIA

Stjepan Husnjak[1], Ivan Turšić[2], Suzana Žalac[2], Mirko Boić[3], Danijela Vrhovec[1], Vinko Kozumplik[1]

[1] *University of Zagreb, Faculty of Agriculture, Croatia*
[2] *Tobacco Institute, Zagreb, Croatia*
[3] *Croatian Tobaccos, Virovitica, Croatia*

1. INTRODUCTION

In the Drava River Valley, tobacco is an agricultural product of great concern and importance to all and has a long tradition of farming. It is known that tobacco is grown on soils of different physical and chemical properties that have a direct influence on the quality of tobacco. For this reason, systematic field and laboratory investigations of soil and plant material in tobacco production were conducted in Croatia in the period 2006-2008 with the aim of gaining new insights into the soil status and quality of tobacco in regular production and of eliminating the detected restraints.

The main purpose of this paper is to present the results relating to the analysis of heavy metal content in soil and tobacco leaf in view of the influence of heavy metals on the quality of tobacco.

2. MATERIALS AND METHOD

The sampling and identification of soil type were conducted in the course of regular tobacco production on 22 representative family farms in the Drava River Valley (Fig. 1.).

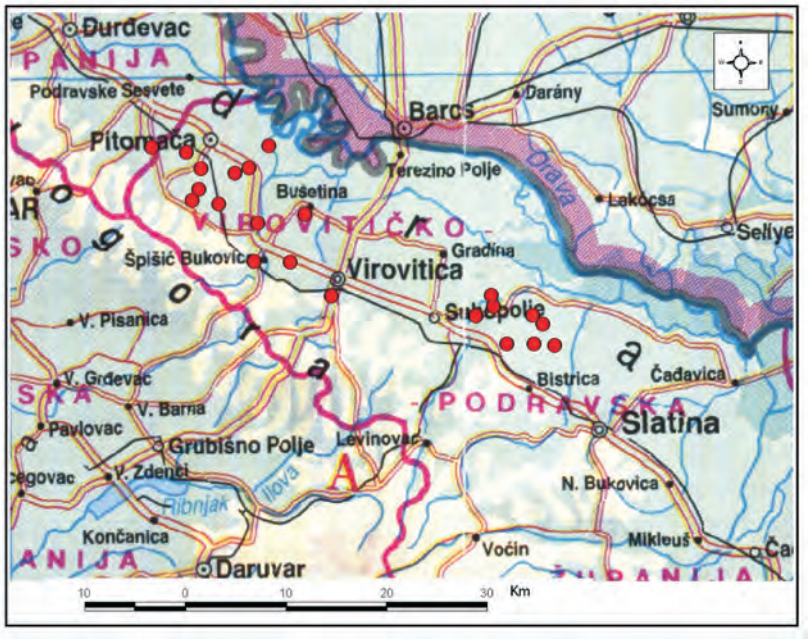

Figure 1. Soil sampling locations
Сл. 1. Локации на земени почвени примероци

The paper presents the results relating to luvisol on loess in view of the fact that it is the prevailing soil type on which tobacco is grown in the Drava River Valley. Plant samples were taken from the same family farms. Bright Virginia tobacco is grown on all locations. The basic physical and chemical properties of soil were analysed using standard methods (Škorić 1985). Heavy metals were extracted from soil by microwave-assisted digestion method with the Aqua Regia and from the plant material by microwave-assisted digestion method with a mixture of nitric acid and hydrogen peroxide. Concentrations of heavy metals were determined by inductively coupled plasma optical emission spectrometry using a Varian Vista-MPX. The estimation of soil pollution was made pursuant to the criteria contained in the Rulebook on Protection of Agricultural Land against Pollution by Harmful Substances in the Republic of Croatia (Official Gazette of the Republic of Croatia, No. 10/2007). The quality of tobacco in view of heavy metal content was estimated in accordance with values from literature sources (T.S. Tso, 1990).

3. REZULTS

3.1. Physical and chemical soil properties

In the Drava River Valley, luvisol on loess is the prevailing soil type on which tobacco is grown (Husnjak et al., 2005). It is characterised by automorphic moisture regime, loamy texture, medium water-holding capacity, increased compaction, especially in the sub-plough soil layer, and low to high air capacity (Table 1.).

Table 1. The basic physical soil properties (min. and max. values)
Табела 1. Основни физички својства на почвата (мин. и макс. вредности)

Depth (cm) Длабочина	**Particle content (%)**			**Porosity % vol. Порозност**	**Kv % vol.**	**Kz % vol.**	**qv g/cm^3**	**GP g/cm^3**
	Sand Песок	Silt Прав	Clay Глина					
24-35*	17,0-56,4	32,4-71,9	10,2-15,4	36,3-54,6	30,1-40,2	4,8-21,5	1,21-1,68	1,33-1,81
38-45**	15,1-54,8	30,9-64,4	12,3-23,8	36,7-47,1	32,3-40,1	0,9-12,7	1,43-1,69	1,61-1,80

*Ploughed layer; **sub-plough layer: Kv-water-holding capacity; Kz-soil air capacity; qv-bulk density; GP-packing density
*Ораничен слој; **Подораничен слој: Kv-ретенцилен воден капацитет; Kz-воздушен капацитет на почвата; qv-привидна густина; GP-Спакуваност

According to the presented results of chemical analyses, it is evident that luvisol soils have from very strong to strong acid reaction, from very low to low humus content and from poor to good nutrient supply (Table 2.).

Table 2. The basic chemical soil properties (min. and max. values)
Табела 1. Основни хемиски својства на почвата (мин. и макс. вредности)

Depth (cm) Длабочина	**Soil reaction (pH) Реакција на почвата**		**Humus % Хумус**	**N % Азот**	**mg/100 g soil mg/100 g почва**	
	H_2O	M KCl			P_2O_5	K_2O
24-35	4,14-5,96	3,65-5,45	0,6-2,8	0,03-0,16	3,9-43,1	12,2-27,0
38-45	4,44-6,52	3,88-5,68	0,1-2,7	0,00-0,15	2,0-38,6	4,8-23,5

3.2. Heavy metal content in soil

When comparing heavy metal content in soil with the allowable threshold limit values for soils of loamy texture, it can be concluded that soils used for tobacco production are not contaminated by heavy metals.

Table 3. Heavy metal content in the plough soil layer (mg/kg)
Табела 3. Содржина на тешки метали во ораничниот слој

Heavy metal Тешки метали	Minimum Минимум	Maximum Максимум	Average Просек	Allowable threshold limit values* Праг на дозволени гранични вредности*
Cadmium (Cd)	0,09	0,33	0,14	0,5-1,0
Chromium (Cr)	11,05	41,63	26,18	40-80
Copper (Cu)	7,22	21,24	11,55	60-90
Manganese (Mn)	419,6	1035,5	642,4	-
Molybdenum (Mo)	<0,20	1,31	0,44	-
Nickel (Ni)	8,94	21,51	13,44	30-50
Lead (Pb)	7,20	13,17	9,58	50-100
Zinc (Zn)	24,49	56,14	37,17	60-150

* For soils of loamy texture
* За почви со глинеста текстура

3.3. Heavy metal content in a dried tobacco leaf

When comparing heavy metal content in a dried tobacco leaf with literature values (T.S. Tso, 1990), it was established that the average values of heavy metal contents are within limit values as set out in the literature sources (Table 4).

Table 4. Heavy metal content in a dried tobacco leaf (mg/kg)
Табела 3. Содржина на тешки метали во сув тутунски лист

Heavy metal Тешки метали	Minimum Минимум	Maximum Максимум	Average Просек	Allowable threshold limit values* Праг на дозволени гранични вредности*
Cadmium (Cd)	0,64	3,99	1,97	3,0
Chromium (Cr)	<0,4	1,82	1,1	in trace
Copper (Cu)	4,54	33,86	14,78	15-21
Manganese (Mn)	36,9	584,6	170,3	140-700
Molybdenum (Mo)	<0,4	0,90	0,66	in trace
Nickel (Ni)	1,26	6,21	2,59	0,2-1,6
Lead (Pb)	<1,4	2,44	1,87	0-200
Zinc (Zn)	10,26	52,51	29,04	50-85

3.4. The influence of heavy metal content in soil on their content in a dried tobacco leaf

By comparison of the results obtained by heavy metal analysis in soil with those obtained from plant material (tobacco leaf), it was established that there was no statistical correlation between the above parameters. Only in the case of chromium, a significant negative correlation was found between content in soil and plant material (Fig. 2).

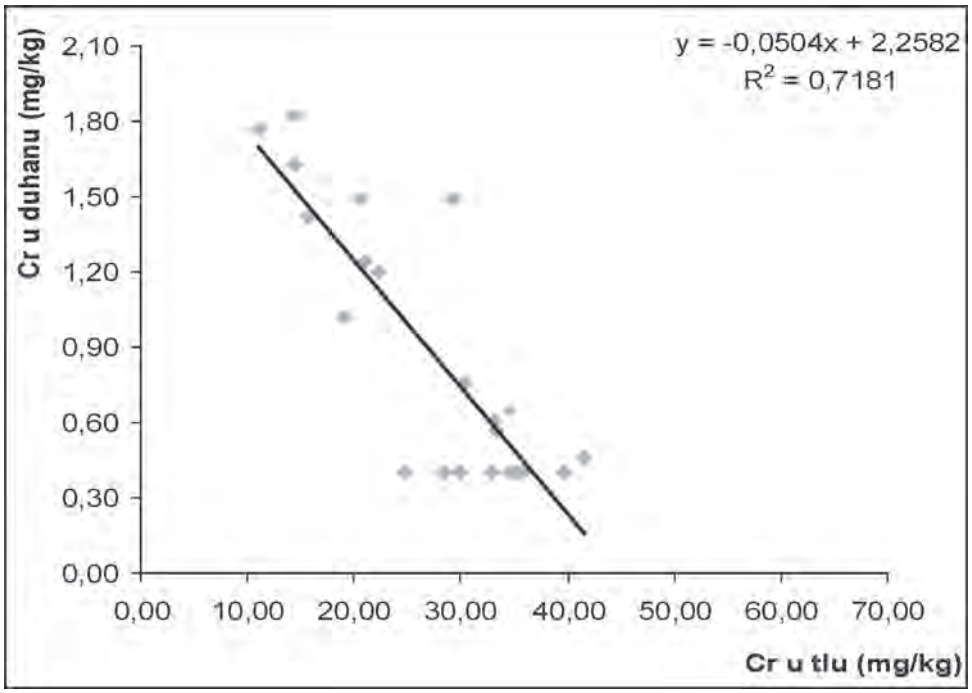

Figure 2. Comparison between the chromium content in soil and tobacco leaf
Граф. 2. Споредба помеѓу содржината на хром во почвата и тутунскиот лист

Based on the above, it can be concluded that metal content in soil has a little or no influence on the heavy metal content in tobacco leaf, indicating that the absorption of elements from the soil is influenced, individually and/or interactively, by several parameters e.g. soil reaction (pH), content of organic matter (humus), cation exchange capacity, mechanical content (percentage clay content), content and type of secondary clay minerals, etc.

In support of this interpretation, we point out to the established positive correlation between clay content in soil and heavy metal content in tobacco leaf, especially Cd, Cu, Ni, Pb, and Zn, and between soil reaction (pH) and content of Cr, Mn, and Mo, confirming the fact that the lighter, sandy soils are more suitable for tobacco production than the soils of clayey and loamy texture.

4. CONCLUSION

This paper presents the results showing heavy metal content in tobacco leaf and luvisol on loess, having in view that this type of soil is the prevailing one in tobacco production in the Drava River Valley.

The soils used for tobacco production in Croatia are not contaminated by heavy metals, in consideration of the fact that their concentrations are below allowable threshold limit values in conventional and ecological agriculture.

By comparison of the results of heavy metal content in soil with those in tobacco leaf, it was established that only in the case of chromium, there was a significant statistical negative linear correlation.

Since the tobacco-growing soils are not contaminated by heavy metals, the heavy metal content in tobacco leaf is within the permitted concentrations.

5. LITERATURE

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[1] University of Zagreb, Faculty of Agriculture, Croatia
[2] Tobacco Institute, Zagreb, Croatia
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SUMMARY

In Croatia tobacco is produced on soils of different physical and chemical characteristics, which has a direct reflection on tobacco quality. For this reason, systematic field and laboratory investigations of soil and plant material were conducted in the tobacco growing region of the Drava River Valley in the period 2006-2008 with the aim to get a better insight into the soil status and tobacco quality and to eliminate the detected restraints. As luvisol on loess is the prevailing soil type on which tobacco is grown in the Drava Valley, this paper presents the investigation results relating to the contents of some heavy metals (Cd, Cr, Cu, Mn, Mo, Ni, Pb, and Zn) in this soil type and to their accumulation in tobacco leaf. Soil and plant samples were taken from 22 locations, i.e., 22 family farms. Concentrations of particular elements were determined by inductively coupled plasma optical emission spectrometry. Comparison of concentrations of metal with allowable threshold values showed that soils used for tobacco productions are not contaminated by heavy metals, since their concentrations are below allowable threshold values and that the heavy metal content in dried tobacco leaf is in accord with literature values. Comparison of the results on heavy metal contents in soil and in tobacco leaf did not reveal their significant statistical interdependence, which points to he conclusion that accumulation of studied metals in leaf is not influenced by their content in the soil, but is rather a consequence of the interaction of pedophysical and pedochemical parameters, as well as of the applied technology.

Author's address:
Stjepan Husnjak
University of Zagreb, Faculty of Agriculture
Svetošimunska 25, 10000 Zagreb
Croatia