

**EFFECT OF ORGANIC AMENDMENTS ON QUALITY OF ORIENTAL TOBACCO
KRUMOVGRAD 90 GROWN IN INDUSTRIALLY POLLUTED REGION
(FIELD EXPERIMENT)**

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Abstract

A comparative research on the impact of organic amendments on the uptake of heavy metals, micro and macroelements and quality of Oriental tobacco Krumovgrad 90 has been carried out. The experiment was performed on an agricultural field contaminated by the Non-Ferrous-Metal Works near Plovdiv, Bulgaria. The field experimental was a randomised complete block design containing five treatments (addition of 20 t/daa and 40 t/daa of vermicompost to the soil, addition of 20 t/daa and 40 t/da of compost to the soil and control variant). Upon reaching commercial ripeness, the tobacco plants were gathered. Heavy metal, micro and macroelement contents in leaves of Oriental tobacco were analysed by the method of the microwave mineralization. To determine the heavy metals, micro and macroelements in the samples, inductively coupled emission spectrometry was used. Tested organic amendments significantly influenced the uptake of heavy metals, micro and macroelements by the leaves of Oriental tobacco. The addition of compost and vermicompost resulting in increased uptake of macro elements potassium, calcium and magnesium, and leads to improvement of the life status of the Oriental tobacco plant, and has a beneficial effect on burning properties of tobacco. Organic amendments influence tobacco quality indicators (ash, protein and reducing sugars). Adding 40 t/daa compost and 40 t/daa vermicompost to soils leads to improved tobacco quality compared to the control. However, the introduction of 20 t/daa of compost and 20 t/daa of vermicompost into the soil results in lower quality tobacco (Schmuck number below 0.5).

Keywords: *chemical composition, compost, vermicompost, Oriental tobacco, polluted soils, quality*

1. INTRODUCTION

Tobacco is a major agricultural crop for many countries, including Bulgaria. Appropriate climatic conditions in the country determine the cultivation of high-quality oriental tobaccos that are distinguished by their specific smoking and technological properties. Among the Bulgarian oriental tobaccos, Krumovgrad origin is most common in the production and best realizing in the international markets. The quality of the tobacco is largely determined by its chemical composition. The study of the chemical composition of the tobacco is primarily associated with its technological qualities, mainly with the combustibility but tobacco consumption makes them significant also in terms of their biological effects on human health. This issue is particularly important given the ability of the tobacco to accumulate heavy metals, and the ability of part of them to be emitted in the main and side tobacco smoke stream [1]. Chemical properties of tobacco depend on many factors, among which the following should be noted: variety, habitat (soil and climate), as well as the impact of agro-technical practices on the physical, chemical and biological properties of the soil. Soil conditions and nutrient content are crucial for the growth and development of plants. Yield and quality of tobacco is strongly influenced by fertilization and especially by the introduction of nitrogen and potassium fertilizers [2]. The use of organic fertilizers can affect the physicochemical properties of the soil and can improve the conditions for crop development. Also, the organic fertilizer can neutralize or reduce the acidity of the soil and can increase the content of certain trace elements such as zinc and copper. Organic fertilizers can increase the weight of tobacco leaves and yield. The efficiency of organic fertilization is manifested in rapid growth, earlier senescence of leaves, and improvement of the combustibility of the leaves [3]. The increasing application of organic fertilizers leads to improvement of the soil's ability to

deliver nutrients, in this way providing enough quantities of N, P, and K for the development of tobacco [4].

Phytoremediation can be defined as the combined use of plants, soil amendments and agronomic practices to remove pollutants from the environment or to decrease their toxicity [5]. This technique has many advantages compared with other remediation procedures – low economic costs and the possibility of being applied to soils, causing a minimum environmental impact. As a technology based on the use of plants, the success of phytoremediation will mainly depend on the proper selection of plants. Many researchers examine the rapidly growing, high biomass plants, including agronomic crops for their ability to tolerate and accumulate metals in their shoots.

Tobacco is a crop that has an exceptional ability to accumulate more Cd in its leaves than any other crop [6,7]. The plant has even been considered to be a Cd-hyperaccumulator, and has already been used in the treatment of Cd-contaminated soil because of its outstanding characteristics as a phytoremediator, such as rapid growth, high biomass and so on [8,9]. The Cd accumulation and tolerance characteristics of tobacco are related to initial Cd concentration in the soil, exposure time, *Nicotiana* species, and other variables [10].

The addition of organic matter amendments, such as compost, fertilizers, and wastes, is a common practice for immobilization of heavy metals and soil amelioration of contaminated soils [11]. The effect of organic matter amendments on heavy metal bioavailability depends on the nature of the organic matter, their microbial degradability, salt content and effects on soil pH and redox potential, as well as on the particular soil type and metals concerned [12].

The use of organic fertilizers influences the physicochemical properties of soils and improves the conditions for the development of crops. Organic fertilizers can neutralize or reduce the acidity of the soil and increase the content of certain microelements, such as Zn and Cu. The efficiency of organic fertilization is manifested in rapid growth, earlier maturation, improvement in the flammability of leaves, their mass and yield [13]. There is evidence that the use of combined inorganic and organic fertilizers can improve the growth and quality of tobacco [3].

The increasing application of organic fertilizers improves the soil's ability to supply nutrients, thus providing sufficient amounts of N, P, and K for the development of tobacco [14]. On the other hand, organic fertilizers can improve the resistance of the tobacco plant to diseases [15].

The purpose of this study was to conduct a comparative study that would allow us to determine the influence of organic amendments (compost and vermicompost) on chemical composition and quality of Oriental tobacco variety Krumovgrad 90, as well as the possibilities to use the plant for phytoremediation of heavy metal contaminated soils.

2. MATERIALS AND METHODS

2.1. Materials

The experiment was performed on an agricultural field contaminated by the Non-Ferrous-Metal Works near Plovdiv, Bulgaria. The field experimental was a randomised complete block design containing five treatments and four replications (20 plots): 1 – addition of 20 t/daa of vermicompost to the soil, 2 - addition of 40 t/daa of vermicompost to the soil, 3 - addition of 20 t/daa of compost to the soil, 4 - addition of 40 t/daa of compost to the soil, 5 - control variant.

Characteristics of soils and organic amendments are shown in Table 1. The soils used in this experiment were slightly acidic, with moderate content of organic matter and essential nutrients (N, P, and K) (Table 1). The total content of Zn, Pb and Cd is high (1430.7 mg/kg Zn, 876.5 mg/kg Pb and 31.4 mg/kg Cd, respectively) and exceeds the maximum permissible concentrations (320 mg/kg Zn, 100 mg/kg Pb, 2.0 mg/kg Cd).

Parameter	Soil	Compost	Vermicompost
pH	7.6	6.9	7.5
Organic matter (%)	3.99	72.10	38.58
N Kjeldal (%)	0.24	2.22	1.57
P (mg/kg)	642	12654	10211
K (mg/kg)	5518	6082	10495
Ca, mg/kg	10607.5	32158.7	31848
Mg, mg/kg	9577.5	2086.5	7754.9
Pb (mg/kg)	876.5	12.0	32.3
Zn (mg/kg)	1430.7	170.8	270.3
Cd (mg/kg)	31.4	0.19	0.69
Cu, mg/kg	124.8	43.23	53.33
Fe, mg/kg	41650.9	3177.31	11813.7
Mn, mg/kg	1244.5	360.48	423.3

Table 1. Characterisation of the soil and the organic amendments used in the experiment

Technically senescent leaves of various stem positions were taken for analysis. As the leaves of oriental tobacco ripen sequentially, harvesting is done in stages /harvests/ by following the sequence of senescence of leaves. Harvesting of leaves is carried out for 3 harvests (bottom leaves, middle leaves and upper leaves). The collected technically senescent leaves were strung on a single needle and dried in natural conditions, observing the technology of solar drying of oriental tobacco. Because Pb, Zn, and Cd accumulate less in the lower leaves than in the middle and upper leaves, only the middle leaves were analysed.

2.2. Methods

The content of heavy metals, micro and macronutrients in tobacco leaves was determined by the method of microwave mineralization. The total content of metals in the soil was determined in accordance with ISO 11466 [16]. The quantitative measurements were carried out with inductively coupled plasma emission spectrometry (ICP) (Jobin Yvon Emission - JY 38 S, France).

In the dried leaves, the content of substances was determined, directly related to the quality and the smoking properties of tobacco - total nitrogen, protein, reducing substances, mineral substances, nicotine. Analyses were carried out according to conventional methods [17,18], as they are expressed in percentage by dry matter.

3. RESULTS

The results for the influence of organic amendments on the accumulation and distribution of heavy metals, micro and macroelements in the leaves of tobacco are shown in Figure 1. The results obtained by us show that the uptake of the elements by the oriental tobacco is influenced by the organic amendments imported to the soil (type and quantity). The addition of compost and vermicompost significantly affect the absorption of heavy metals (Pb, Zn and Cd), micro and macroelements of the tested plants, and depends to a considerable extent by their quantity.

Table 2 presents the results of the impact of compost on chemical parameters (content of mineral substances, soluble carbohydrates, proteins, total nitrogen and nicotine).

Table 3 presents indexes, determining the quality of Oriental tobacco Krumovgrad 90 (total reducing substances/nicotine index, total reducing substances/ash index, total nitrogen/nicotine index, total reducing substances/proteins (Schmuck's number)).

Table 4 presents the results of characteristics of tobacco samples according to expert evaluation.

4. DISCUSSION

4.1. Effect of organic amendments on accumulation of heavy metals, micro and macroelements in vegetative organs of Oriental tobacco

The addition of compost and vermicompost results in a slight decrease in the Pb, Zn and Cd content of the tobacco leaves compared to the control (without amendemnts), this decrease being more pronounced at 20 t/daa of vermicompost. Adding a compost and vermicompost also leads to a decrease in the Cu and Fe content in the leaves relative compared to the control, this decrease being more pronounced at 40 t/daa of compost and 20 t/daa vermicompost, whereas the content of Mn increase. Both organic additives lead to an increase in the content of macronutrients in the leaves of oriental tobacco, as the largest increase was observed for magnesium and calcium in the addition of 20 t/daa of compost and 20 t/daa of vermicompost, and for potassium and phosphorus - in the addition of 40 t/daa of compost and 20 t/daa of vermicompost..

The lead content in tobacco leaves reached to 522.8 mg/kg in the control (without amendments), and from 420.5 to 502.6 mg/kg in variants with addition of compost and from 336.2 to 411.8 mg/kg in variants with addition of vermicompost. Visible symptoms, caused by high levels of Pb, which occur in tobacco - dark green leaves, leafroll of old leaves, dark brown and short roots, were not observed in our experiments. According to Tso [19], the content of Pb in tobacco leaves varies widely - from 0 to 200 mg/kg, and depends largely on the soil characteristics, the type and variety of tobacco, as well as the place of cultivation [10]. The greater accumulation of Pb in tobacco leaves is probably due to Pb absorption from the soil through the root system of the plant and their movement through the conductive system, as well as the heavy-metal containing aerosols falling from the atmosphere. The addition of compost and vermicompost leads to an insignificant decrease of the lead content in tobacco leaves (Fig.1).

The cadmium content in tobacco leaves reached to 78.6 mg/kg in the control, and from 72.1 to 76.5 mg/kg in variants with addition of compost and from 70.6 to 74.5 mg/kg in variants with addition of vermicompost. Visible symptoms caused by the increased content of Cd in plants, such as growth arrest, damage to the root system, chlorosis on leaves, reddish to dark brown colour on their edges, were not observed. The cadmium content of tobacco leaves reaches 78.6 mg/kg. According to Golia et al. [20], the Cd content in tobacco varies from 0.5 to 3.5 mg/kg., while Tso [19] reports a values reaching up to 11.6 mg/kg. According to Mench et al. [7] and Sappin-Didier et al. [21], Cd content in tobacco leaves varies from 40 to 120 mg/kg depending on the soil characteristics. The results obtained are consistent with the values reported in other literature sources [22.23] and higher than the concentrations considered critical in plants (5-30 mg/kg) [24]. It has been found that cadmium can be accumulated in tobacco leaves in an amount 10 times higher than that in the soil [25]. The greater accumulation of Cd in tobacco leaves is probably due to Cd absorption from the soil through the root system of the plant and their movement through the conductive system. This is consistent with what was found by Yeargan et al. [26], who found that tobacco had an extraordinary ability to digest Cd as compared to other plants when grown on Cd contaminated soils. Addition of compost and vermicompost leads to an insignificant reduction of cadmium in tobacco leaves.

The zinc content in tobacco leaves reached to 451.0 mg/kg in the control, and from 355.3 to 392.3 mg/kg in variants with addition of compost and from 290.1 to 325.3 mg/kg in variants with addition of vermicompost. Symptoms of zinc toxicity which manifest themselves as chlorosis and necrosis at the edges of the leaves, inter-veinal chlorosis in young leaves, plant growth arrest as a whole, damage to the roots, were not observed as well. According to Jones et al. [27] and Campbell [28], the optimum

amount of Zn in the tobacco is in the range 20 - 60 (80) mg/kg, and excess is observed at values above 80-100 mg/kg.

According to Campbell [28] the optimum values of copper for tobacco are 5-10 mg/kg, whereas Zaprjanova and Bozhinova [29] found that level of Cu in tobacco is in the range 11.9-13.3 mg/kg. The values identified by us for Cu in the leaves from untreated tobacco plants reached to 44.1 mg/kg. The addition of compost decreases the content of zinc and copper in tobacco leaves (Fig. 1).

The iron content in tobacco leaves reached to 207.1 mg/kg in the control, and from 144.6 to 193.5 mg/kg in variants with addition of compost and from 264.3 to 332.1 mg/kg in variants with addition of vermicompost. In scientific literature the optimal iron content in tobacco leaves is 50 to 300 mg/kg [27], whereas 40-50 mg/kg is considered low concentration depending on the stage of plant development [30]. The iron content established by us in the technically senesced leaves is above the indicated critical value for tobacco. The addition of compost leads to decrease of the iron content in the tobacco leaves, whereas the addition of vermicompost increased Fe content in leaves (Fig. 1).

The manganese content in tobacco leaves reached to 63.2 mg/kg in the control, and from 83.5 to 87.8 mg/kg in variants with addition of compost and from 71.9 to 80.7 mg/kg in variants with addition of vermicompost. Tobacco leaves contain manganese above the lower limit of 20 ppm indicated by Campbell [28]. The addition of compost and vermicompost results in increased manganese content in leaves (Fig. 1).

Mineral substances have a direct impact on tobacco combustibility. If there is a favourable ratio between the elements, tobacco has a good combustibility, which is characterized by uniform and sufficiently intense smoldering.

The content of P in the leaves of tobacco plants reached to 0.19% in the control, and from 0.20 to 0.23% in variants with addition of compost and from 0.20 to 0.22% in variants with addition of vermicompost. Phosphorus content in tobacco leaves, depending on the stage of development, ranges from 0.1 to 1% and observed concentrations in technically senesced leaves of Oriental tobacco are similar to those reported by Jones et al. [27]. The addition of compost and vermicompost results in increased phosphorus content in leaves.

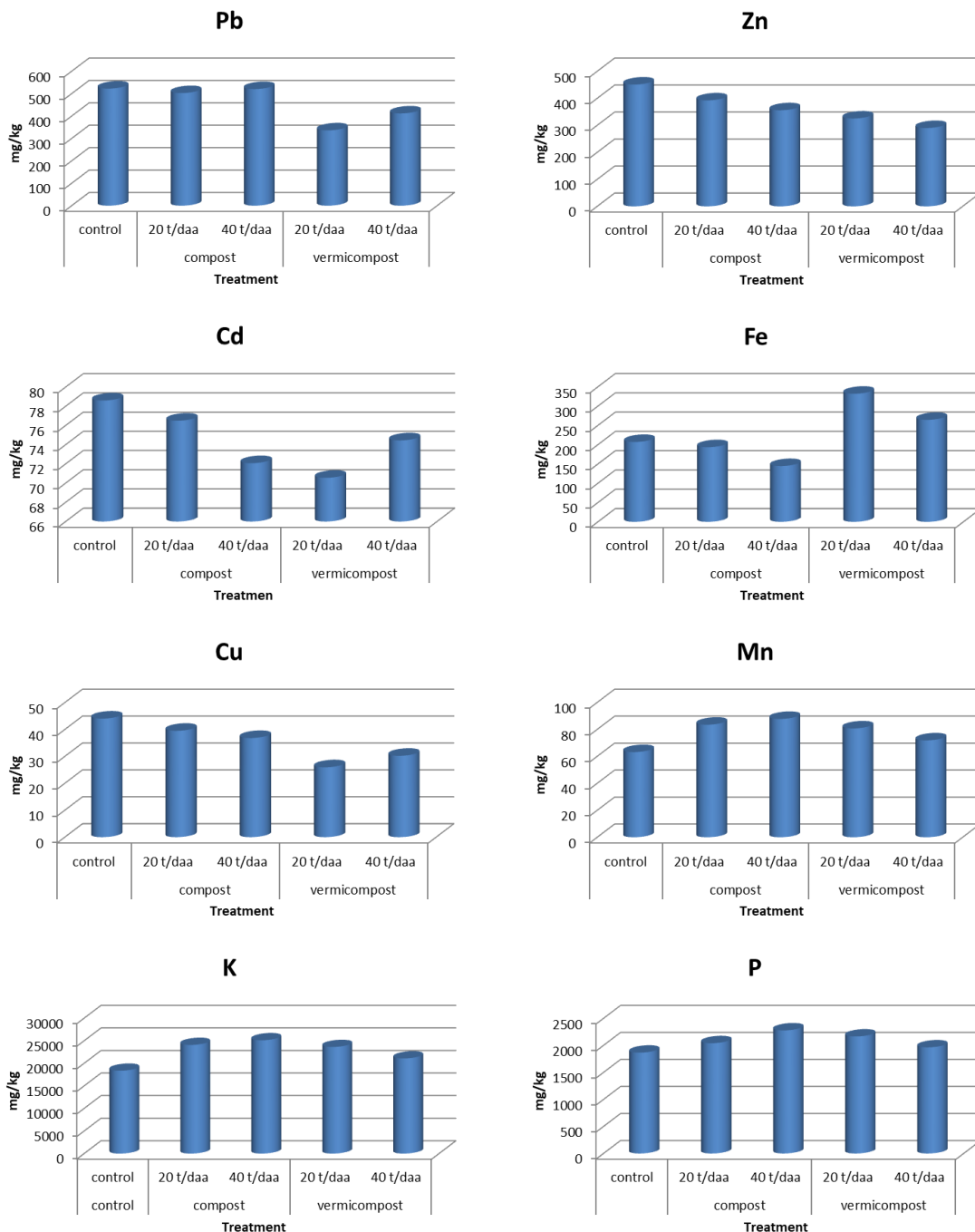
The content of K in the leaves of tobacco plants reached to 1.84% in the control, and from 2.4 to 2.5% mg/kg in variants with addition of compost and from 2.1 to 2.4 % in variants with addition of vermicompost. These values are similar to those reported by Volodarskiy [31], according to which the content of K in the leaves 2.5-4.2% has a positive influence on tobacco combustibility.

The calcium content in tobacco leaves reached to 2.55% in the control, and from 2.73 to 3.25% in variants with addition of compost and from 3.48 to 4.39% in variants with addition of vermicompost. These values are similar to those reported by Jones et al. [27]. The addition of compost and vermicompost in soil results in an increase of the calcium content in tobacco leaves.

The minimum magnesium content in tobacco leaves, where symptoms of insufficiency do not appear, is about 0.25% [19]. According to Yancheva [32] the content of magnesium in technically senesced leaves of oriental tobacco is changed in a narrow range - from 0.33 to 0.69% and depends mainly on the location of the leaves to the stem. According to McCants and Woltz [33] plant in Mg deficiency have a lower content of the element in the lower leaves in comparison to the upper ones, while in normal supply, the highest concentration of Mg in the lower leaves. The magnesium content established by us in technically senesced leaves is above the critical value for tobacco. The organic additives lead to increase in the magnesium content in tobacco leaves (Fig. 1).

The K/Ca ratio is important for the quality of tobacco raw material and mainly associated with it is the structure of tobacco leaf and combustibility. When calcium prevails over potassium, raw material is obtained with poor elastic properties and volume. Our results show that Ca content in tobacco leaves from control plants prevails over the content of K. The addition of compost in the soil leads to increased contents of potassium and calcium, the K/Ca ratio in the leaves is increased from 0.72 in control plants to 0.92 with addition of 40 t/daa compost, whereas addition of vermicompost leads to decreased the K/Ca ratio (Fig.1).

There is a clear correlation between the amount of compost added and heavy metals content in leaves. By increasing the amount of compost the elements content in leaves is reduced. The decrease in Cd content in leaves is more pronounced in the 40 t/daa compost variant, suggesting that the introduction of 20 t/daa of meliorant is not enough to reduce the amount of Cd. Higher doses of meliorant may be more effective but economically unjustified. The vermicompost influence on the heavy metal content the tobacco leaves is not unidirectional.



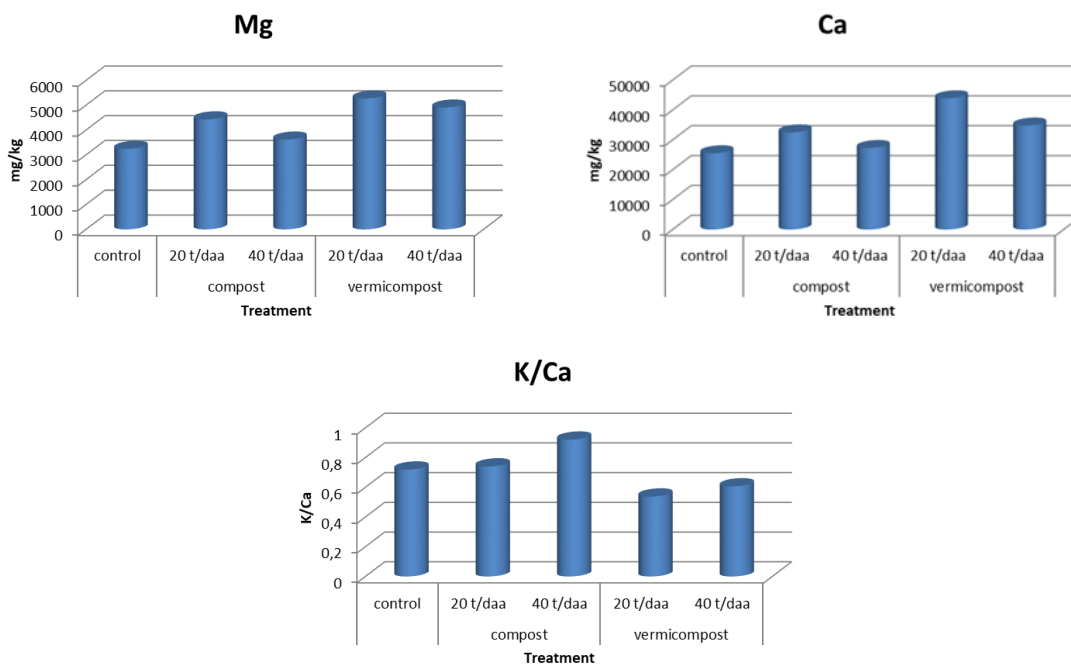


Fig. 1. Effect of compost and vermicompost amendments on uptake of heavy metals, micro and macronutrients in Oriental tobacco leaves (variety Krumovgrad 90)

4.2. Effect of compost on quality of Oriental tobacco

The content of mineral substances (ash) has well-expressed correlation with the fleshiness of tobacco leaves, and from there with their quality. According to Gyuselev [34] ash content in dried leaves of oriental tobacco ranges from 12% to 15%. The ash content in tobacco leaves reached to 14.83% in the control (Table 2) and from 15.87 to 16.97% in variants with addition of compost and from 17.17 to 18.07% in variants with addition of vermicompost. The increase in the ash content compared to the control sample is evident in the addition of compost and vermicompost in the soil. The increase in the amount of macro elements leads to the increase of ash content.

Treatments	Mineral substances, %	Soluble carbohydrates, %	Proteins, %	Total nitrogen, %, %	Nicotine, %
control	14.83	11.13	17.16	2.75	1.16
20 t/daa compost	16.97	8.26	18.58	2.97	1.52
40 t/daa compost	15.87	12.37	15.76	2.52	1.04
20 t/daa vermicompost	18.07	7.18	22.28	3.57	1.48
40 t/daa vermicompost	16.97	11.29	19.46	3.12	1.00

Table 2. Chemical composition (%) of dried tobacco leaves, variety Krumovgrad 90

The influence of protein substances on consumer qualities of tobacco is generally negative, since pyrolysis of proteins produces nitrogenous substances in tobacco smoke with unpleasant odour and

irritating taste. The content of proteins in tobacco leaves reached to 17.16% in the control (Table 2) and from 15.76 to 18.58% in variants with addition of compost and from 19.46 to 22.28% in variants with addition of vermicompost. The increase in protein in leaves compared to the control sample is strongly expressed in the addition of 20 t/daa compost and 20t/daa and 40 t/daa vermicompost.

The supply of nitrogen is the most important factor influencing the quality of tobacco [35,36]. The use of organic fertilizers leads to increase the content of nitrogen and nicotine in the leaves of oriental tobacco and Virginia. Controlled release of nitrogen from organic fertilizers can be useful practice for increasing the content of nicotine in tobacco. The availability of nitrogen in the later stages of development of tobacco is a critical factor influencing the content of nicotine in the leaves. Ju et al. [35] reported that the mineralization of nitrogen in later stages is an important factor influencing the accumulation of nitrogen and hence the content of nicotine in the leaves. Wang et al.[37] reported that the content of nicotine in the leaves of tobacco increases in the later stages of development, especially after the crushing of the blossoms. Nicotine is the most important alkaloid contained in tobacco and an indicator of its quality. The nicotine content in the tobacco leaves varies between 0.05% (Virginia tobacco) through 3 - 4% ("Burley") to 7.5% (Nicotiana rustica "Machorka", Russia) [34]. Oriental tobacco Kroumovgrad 90 is characterized by an average content of nicotine (approximately 1.3%). The nicotine content established by us in the technically senescent leaves is above the indicated value for Oriental tobacco. The nicotine content reached to 1.16 % in the control and from 1.04 to 1.52 % in variants with addition of compost and from 1.0 to 1.48 % in variants with addition of vermicompost. The results show that the nicotine level of tobacco leaves increases in variants with addition of 20 t/daa compost and 20 t/daa vermicompost and decreases in variants with addition of 40 t/daa compost and 40 t/daa vermicompost.

Treatments	Index			
	1	2	3	4
control	9.59	0.75	2.37	0.65
20 t/daa compost	5.43	0.49	1.95	0.44
40 t/daa compost	11.89	0.78	2.42	0.78
20 t/daa vermicompost	4.85	0.40	2.41	0.32
40 t/daa vermicompost	11.29	0.67	3.12	0.58

1- Total reducing substances/nicotine index, 2- Total reducing substances/ash index, 3- Total nitrogen/nicotine index, 4- Total reducing substances/proteins (Schmuck's number)

Table 3. Indexes, determining the quality of Oriental tobacco Krumovgrad 90

Oriental tobaccos contain significant amounts of reducing sugars and small amounts of protein. According to Gyuselev [34] the average content of soluble carbohydrates in oriental tobaccos ranges from 10 to 18%. At very high content of soluble carbohydrates - over 16 % for oriental tobaccos and low content of nitrogen compounds, a lopsided taste with insufficient completeness is obtained, and the burning sensation is enhanced. The soluble carbohydrates content reached to 11.14% in the control and from 8.26 to 12.37 % in variants with addition of compost. and from 7.18 to 11.29% in variants with addition of vermicompost. The addition of 20 t/daa compost and 20 t/daa vermicompost in soil leads to lower content of soluble carbohydrates in tobacco leaves. Determining the quality of tobacco by its chemical composition is more widely used in practice. It was found that chemical substances contained in tobacco and its smoke, its effects can be divided into two main groups - substances that cause pleasurable sensations – i.e. positively affecting substances and substances that cause unpleasant sensations – i.e. negatively affecting substances. Schmuk [38] allocated to the first group of soluble carbohydrates and nicotine content at levels up to 1.5%, and the second to the protein. Different

chemical factors have been developed and are offered on the quality of tobacco, representing a proportion between favourable and unfavourable affecting substances.

For the objective determination of the quality of light tobaccos, especially important is the balance between the main components of the chemical composition expressed in various ratios. The addition of compost leads to a slight change in these indicators. The total reducing substances/ash index, providing information for the fleshiness of the tobacco, reached to 0.75 in the untreated tobacco plants and from 0.49 to 0.78 in tobacco with addition of compost and from 0.40 to 0.67% in tobacco with addition of vermicompost (Table 3).

The reducing substances/nicotine index reached to 9.59 in control plants and from 5.43 to 11.89 in treated plants with compost and from 4.85 to 11.29 with vermicompost. The total nitrogen/nicotine index reached to 2.37 in control plants and is in the range from 1.95 to 2.42 in treated plants with compost and from 2.41 to 3.12 with vermicompost (Table 3).

With the help of the Schmuck's number (ratio of soluble carbohydrates and proteins) the main quality categories of oriental tobaccos can be objectively characterized. Quality tobacco has value over 1.0, average quality - between 0.5 and 1.0, and low-quality - below 0.5. Schmuck's number ranges from 0.64 in the control sample, from 0.44 to 0.78 in the variants with compost and from 0.32 to 0.58 in variants with vermicompost.

The indicators of the chemical composition characterize the oriental tobacco leaves as quality and of average quality, which correlates very well with the results of the expert evaluation of the tobacco samples (Table 4). The resulting values are typical for tobacco of Krumovgrad origin (variety Krumovgrad 90) grown in field conditions. The addition of compost and vermicompost affects the quality of tobacco. The most favourable effect is the addition of 40 t/daa compost and 40 t/daa vermicompost, which maintains the ratios of indicators similar to the control, and improves the quality of tobacco. In the variant with the introduction of 20 t/daa compost, a decrease in the amount of reducing sugars and an increase in minerals (ash) and total nitrogen is found, which leads to a slight deterioration in the quality of tobacco. The most unfavourable are the import of 20 t/daa vermicompost, in which the chemical composition of tobacco falls into the category of medium quality material.

Treatments	Expert evaluation
control	Small size leaves (10-13-15 cm). Light yellow to yellow-brown colour, without greenish shades. Good density. No damage.
20 t/daa compost	Small size leaves (10-15 cm). Yellow-orange colour with greenish hues. Slight burn and scarlet fever. Good density.
40 t/daa compost	Small size leaves (10-13-15 cm). Light yellow, orange to light brown, even, without greenish hues. Thick. No damage.
20 t/daa vermicompost	Small size leaves (10-15 cm). Yellow-orange colour with greenish hues. Slight burn and scarlet fever. Good density.
40 t/daa vermicompost	Medium size (from 10 to 29 cm). Light yellow, yellow-orange to light brown colour. Medium density

Table 4. Characteristics of tobacco samples (according to expert evaluation)

5. CONCLUSIONS

Based on the results obtained regarding the impact of organic soil amendments on the uptake of the heavy metals, micro and macroelements by Oriental tobacco, as well as the possibilities to use the plant for phytoremediation, the following conclusions can be made:

1. Tobacco is a crop tolerant to heavy metals and it develops normally when grown on soils contaminated with heavy metals.
2. The effect of the compost and vermicompost used for the reduction of the heavy metal content in Oriental tobacco is negligible. The best results are obtained with the introduction of 40 t/daa of compost and 20% vermicompost.
3. The introduction of compost and vermicompost resulting in increased uptake of macro elements potassium, calcium and magnesium, and leads to improvement of the life status of the tobacco plant, and has a beneficial effect on burning properties of tobacco.
4. Organic amendments influence tobacco quality indicators (ash, protein and reducing sugars). Adding 40 t/daa compost and 40 t/daa vermicompost to soils leads to improved tobacco quality compared to the control. However, the introduction of 20 t/daa of compost and 20 t/daa of vermicompost into the soil results in lower quality tobacco (Schmuck number below 0.5).

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