

**EFFECT OF ORGANIC AMENDMENTS ON CHEMICAL COMPOSITION
AND QUALITY OF ORIENTAL TOBACCO**

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Abstract

There has been carried out a comparative research on the impact of organic soil amendments (peat, compost and vermicompost) on the chemical composition and quality of Oriental tobacco. Incorporation of organic amendments in the soil affect plant height and number of leaves formed. Addition of vermicompost and peat to the soil leads to an increase in the size of the leaves and to a lowering of the quality of the tobacco. The application of the compost is resulting in a slight increase in the size of the leaves and does not impair the quality of the tobacco. Application of the organic amendments leads to increased content of potassium, calcium and magnesium in the leaves of tobacco and therefore may favorably affect burning properties of tobacco. Organic amendments affect the indicators defining the quality of tobacco (ash content, protein and reducing sugars). The introduction of organic amendments to soil resulting in increased mineral substances (pure ash) and quantity of proteins, and reduces the amount of reducing sugars in tobacco leaves in relation to the control. Addition of compost and peat to the soil does not impair the quality of the tobacco compared to the control. The addition of 7.5% and 10% of vermicompost to the soil, however, leads to decrease the quality of tobacco (Schmuk below 0.5).

Key word: organic amendments, Oriental Tobacco, quality, chemical composition

1. INTRODUCTION

Tobacco quality is largely determined by its chemical composition. This primarily applies to the content of nicotine (total alkaloids) and reducing sugars of organic compounds, and the content of nitrogen, potassium, calcium and magnesium of inorganic compounds. Chemical properties of tobacco depend on a number of factors, among which special mention should be made of the cultivar, habitat (soil and climate), and the integral effect of agrotechnical practices on the physical, chemical and biological properties of the soil. Soil conditions and nutrients is very importance for growth and development of plant. In addition to carbon and oxygen which supply from the atmosphere and water, macro elements and micronutrients are necessary for plant growth and production (Kafi, 2002). Yield and quality of tobacco are greatly affected by fertilization and especially by nitrogen (N) and potassium (K) supplies (Spirov and Lukipudis, 1999; Bozhinova and Bozhinov, 2006). Inadequate or excessive nitrogen could give rise to low yield and quality of tobacco. Using organic fertilizers can improve biological activities and a physicochemical property of crop growth environment. Also, organic fertilizers can neutralize or decreases the soil acidity and supply some micronutrients such as zinc, and copper. Organic fertilizers could advance in weight of single tobacco leaf and yield. It had along fertilizer efficiency to induce fast growth, advance leaf maturation and ripe, and make leaf combustibility better. Specially, it was believed that biological organic-inorganic mixed fertilizer could advance in growth, quality and output of tobacco (Hu, 2004; Wang et al., 2009). The increasing application of organic fertilizers obviously improved soil capacity of supplying nutrients, thus enhancing the release of N, P, and K, providing enough K for

tobacco (Cao et al., 2004). Noticeably, organic fertilizer could also improve resistance of tobacco plant to reduce diseases (Li, 2008).

The current investigation was conducted to determine the effect of different organic amendments on chemical composition and quality of Oriental tobacco.

2. MATERIALS AND METHODS

The effects of different organic amendments on chemical composition and quality of Oriental tobacco were studied in a pot trial. The soils used in this experiment were sampled from the vicinity of the area contaminated by the region of Lead and Zinc Complex near Kardjali, Bulgaria. Characteristics of soils and organic amendments are shown in Table 1. The soils were homogenised, without sieving, and stored at field moisture content. Pots were prepared with 9000 ± 100 g of soil (dry weight basis), plus the amendments, which were mixed with the soil. The organic amendments (peat, compost and vermicompost) were applied at 5.0%, 7.5% and 10.0% addition rates (calculated on soil dry weight basis), using three replicates per treatment. A control, which did not receive any amendment, was also included.

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

Parameter	Soil (Kardzali)	Compost	Vermicompost
pH	6.8	6.9	7.5
EC, dS/m	0.3	0.2	2.2
Organic matter,%	1.76	72.9	38.6
N Kjeldal,%	0.23	1.49	1.67
Available P, mg/kg	78	-	-
Available K, mg/kg	3255	-	-
Pseudo total P, mg/kg	360	11885	9588
Pseudo total K, mg/kg	5310	3781	15615
Pseudo total Pb, mg/kg	123.0	29.8	34.4
Pseudo total Zn, mg/kg	244.0	165.8	233.0
Pseudo total Cd, mg/kg	2.5	0.8	0.1
Pseudo total Cu, mg/kg	31.9	30.3	53.0

Oriental tobacco plants (Krumovgrad 90) were used as test plants. When the plants had developed three pairs of leaves, they were transferred to the pots. They were then left to grow in the climate chamber during 56 days, with regular watering and random rotation of pots position.

To determine soil physical and chemical properties, the soil samples were collected 3 months after addition of organic amendments. A soil subsamples were collected from the upper layer (0 - 25 cm) of each pot, air-dried, passed through a 2-mm sieve and characterized for soil pH (H₂O) and electrical conductivity (EC) in deionised water suspension of 1:5 (w/v); total nitrogen by the Kjeldahl method (N

Kjeldahl); total oxidizable organic carbon according to Tjurin's method in modification of Nickitin and Fishman (with titration) (1969); the available phosphorus was determined by the BDS ISO 11263 (2002) and available K was extracted by the 2 N HCl. Pseudo-total metal (Cd, Cu, Pb and Zn) concentrations were determined by flame atomic absorption spectrometry after digestion of the soil and organic amendments samples with aqua regia according to ISO 11466, using Perkin Elmer apparatus (Analyst 200). Three independent replicates were performed for each sample and blanks were measured in parallel.

Mature leaves from different stalk position (lower, middle and upper leaves), were collected for analyses. All samples were washed with tap water to remove any adhering soil particles and rinsed with distilled water, after which they were dried at 75°C for 12 h and ground.

Total nitrogen in the plants was determined by the Kjeldahl method. The preparation of plant samples for analysis of total K, Ca and Mg was determined by dry ashing method. An atomic absorption spectrometer „Analyst 200” (Perkin Elmer) was used for determination of K, Ca and Mg content in the plant samples.

In the dried leaves were determined the content of substances directly related to the quality and the smoking properties of tobacco - protein, reducing sugars and minerals. Analyses were conducted according to accepted methods - proteins (BDS 9142-88) and reducing sugars (ISO 15154).

Results were analyzed using the SPSS statistical package and differences were assessed with the Duncan test at the 0.05 probability level.

3. RESULTS AND DISCUSSION

3.1. Influence of organic amendments on the growth and development of Oriental tobacco
The influence of the organic amendments on the processes of the growth and development of oriental tobacco is determined by phenological observations (surveys) and monitoring of morphological indicators - plant height, number of leaves, the size of the leaves from the lower, middle and upper zones in the technical harvest maturity.

3.1.1. Plant height and number of the leaves per plant

Plant height is directly related to the number of leaves that are borne on a tobacco plant, hence the character may be used as an indicator for the potential number of leaves (Ali *et al.*, 1984). Application of the organic amendments to the soil affect plant height and number of the leaves formed. The analysis of the data in Fig. 1 shows that the used amendments have a positive impact on the growth and number of leaves formed per plant. Increased the height of the plants compared to the control was observed in all variants.

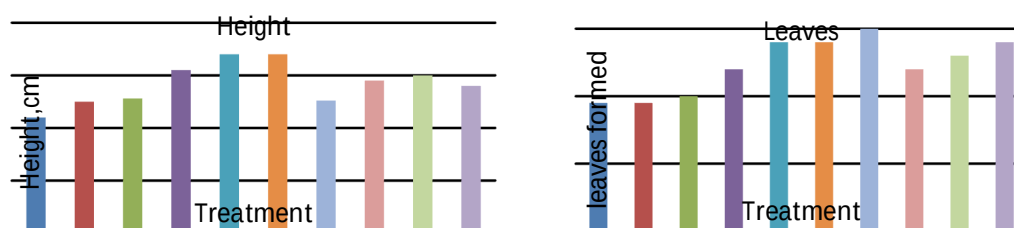


Figure. 1. Effect of organic amendments on the height of the plants and leaves formed of Oriental tobacco

Significant influences on the amount of amendment was observed. With the increase amount of compost

plant height is increased and the number of the technical leaves. The greatest height (155 cm) and the largest number of leaves (24 pieces) in a variant with 10% compost were found. With the increasing the amount of vermicompost plant height decreased from 170 cm to 126 cm, while the number of leaves increased from 28 to 30. The quantity of imported peat in the soil does not have a significant impact on the height and a greater number of leaves (Fig. 1). The options with the addition of organic amendments have greater height and a greater number of technical fit leaves compared to the control. The analysis of the data shows that the quantity of the amendment effect on plant height and number of the leaves formed during the plant development. Changes in the values of soil parameters after the application of organic amendments have a strong influence on the height and number of the leaves per plant. There is a strong positive correlation between the plant height and organic carbon content, as between this biometric parameter and the amount of total nitrogen in the soil.

3.1.2. The size of technical mature leaves

In addition to the number for picking up leaves, yield and quality of the leaves is determined by their size. The length and width of the leaves in the technical maturity varies depending on the harvesting layer. One of the most strictly controlled by merchants technological characteristics in oriental tobacco are the dimensions of leaves and in particular their length. In Table 2 are shown data on the size of the leaves stem from three positions. In all positions stem leaves with smallest dimensions are obtained in the control plants. A relationship between the amount of leaf and stem position was found. Plants are characterized by larger leaves from the lower zone, and the smaller from secondary zone (middle layer). This dependence is observed both in control plants and in treated variants. Analyzing data for the size of the leaves, it may indicate the influence of the amendments when forming linear parameters (length and width) of the lamina (Table 2).

Table 2. Length and width of 7, 14 and 21 leaves (cm), respectively, representative of lower, middle and upper harvesting layer

Variants	7 th leaf		14 th leaf		21 th leaf	
	Length	Width	Length	Width	Length	Width
Control	24.5	14.25	16.3	9.8	12.5	8.5
5% compost	25.25	14.0	18.0	9.8	11.0	7.0
7.5% compost	22.5	14.5	20.5	10.8	11.5	7.5
10% compost	25.0	15.25	23.3	12.2	15.0	9.0
5% vermicompost	31.0	18.0	26.1	13.7	20.0	12.0
7.5% vermicompost	28.5	18.0	30.7	17.2	19.0	12.5
10% vermicompost	29.5	19.0	27.5	14.8	18.3	11.8
5% peat	28.0	18.0	25.2	13.2	17.5	10.3
7.5% peat	25.0	16.25	25.3	12.7	19.0	11.0
10% peat	27.0	15.0	25.8	12.2	17.8	10.8

At least an increase in the size of the leaves was observed in options with the introduction of the compost, and the greatest - in options with the introduction of vermicompost. The length of the leaves from the middle lower with organic options is 26-30 cm, while the variant with peat is approximately 25 cm and

is not influenced by the quantity of imported supplement. The dimensions of the leaves are important not only to the magnitude of yield, but also on the quality of dried tobacco. According to the "minimum quality requirements for Bulgarian raw tobacco, Producer manipulated", published in Official paper 62/13.07.2001, the leaves from the middle-harvesting layer, which can be attributed to the first class must have a length of up to 20 cm. Leaves from the middle and upper zones of control to meet this condition. Meet this condition and leaves from the variant with the compost. The length of the leaves from the middle lower with application of vermicompost ranged from 26 to 30 cm, while the variant with peat the size of the leaves is about 25 cm and is not influenced by the quantity of imported supplement. At least increases the size of the leaves from the middle lower in variants with compost - 18 to 20 cm in relation to the control - 16.3 cm above leaves of all options meet this condition. As seen from the results presented, the introduction of organic amendments affects the increase size of the leaves compared to the control. Incorporation of vermicompost and peat into soil leads to increase in the size of the leaves and consequently, to lowers the quality of the tobacco. The introduction of the compost resulting in a slight increase in the size of the leaves and lowers the quality of the tobacco leaves. Analyzing the data for linear parameters may indicate a strong positive influence on the content of organic carbon and total nitrogen in the soil on the length of the leaves of the three harvest zones (Table 2). Typical of oriental tobaccos is that the size of the leaves is small, so the type distinctively expressed (Ghiuselev, 1983). The length of the leaves from the lower limit harvesting layer exceeds the quality value (20 cm) in the control and all the supplements used. The length of the average leaf harvesting layer exceeds the limit value of the quality option only with the use of vermicompost and peat. Leaves from the upper harvesting layer in the control and all the used supplements meet quality requirements without exception.

3.2. Uptake of macronutrients by the leaves of oriental tobacco

The mineral substances have a direct impact on the tobacco burn well. In the presence of favorable ratio between the individual elements, the tobacco burn well, which is characterized by evenly and with sufficient intensity smoldering. This provides a potential revelation of the smoking properties, which are organic substances (Ghiuselev, 1983). Nitrogen is one of the most important elements affecting the growth and development of tobacco. In addition to having a major nutrient for the tobacco plant, nitrogen is involved in the composition of the nicotine, which is why the quantity of this alkaloid is positively correlated with the content of total nitrogen in the plant. The high nitrogen content in the soil leads to the accumulation of a large amount of total nitrogen in tobacco leaves. For tobacco plants potassium is important not only as a nutrient, linked to its optimum development, but also as an element of which depends largely on the quality of the leaves - the color, the texture, elasticity, burn well. Some of the mineral elements are essential from a technological point of view, a since the role of catalysts, especially when oxidation processes. There is evidence for the catalytic action of magnesium in tobacco fermentation (Ghiuselev, 1983). The results of the influence of organic amendments on the accumulation of macronutrients in the leaves of tobacco are presented in Fig. 2. The results indicate that uptake of macroelements depends on the type of soil amendments and treatment (type and amount). The addition of compost, vermicompost and peat leads to increased macroelements content in the leaves of tobacco compared with the control, and this increase is more pronounced in the incorporation of vermicompost into soil.

The K concentration in mature leaves of control was 4.4% (Fig. 2). These values are similar to those reported by Volodarskiy (1971). According to Volodarskiy (1971) the concentration of K in the leaves of 2.5-4.2% has beneficial influence on the burning properties of tobacco. Organic amendments lead to increased content of potassium in the leaves of tobacco (up to 5.3% in variants with 7.5% compost, 6.1% in the variants with 10% vermicompost and 5.2% in the variants with 10% peat). One possible explanation for this increase is due to the large quantities of mobile potassium in the soil exist in these treatments.

Calcium concentration in leaves from control was 4.26% (Fig. 2). These values are similar to those reported by Yancheva (2002). Organic supplements increase the calcium content in tobacco leaves (up to 2.35% for the variants with 10% compost, 4.72% in the variants with 10% of vermicompost and 4.97% in variants with 7.5% peat.) Our results show a weak relationship between Ca and K concentration in the leaves, and did not confirm the supported hypothesis of an antagonistic relationship between the two elements. The Ca concentration in the leaves decreases with increase potassium content only with the introduction of 7.5% compost, 10% vermicompost and 10% peat.

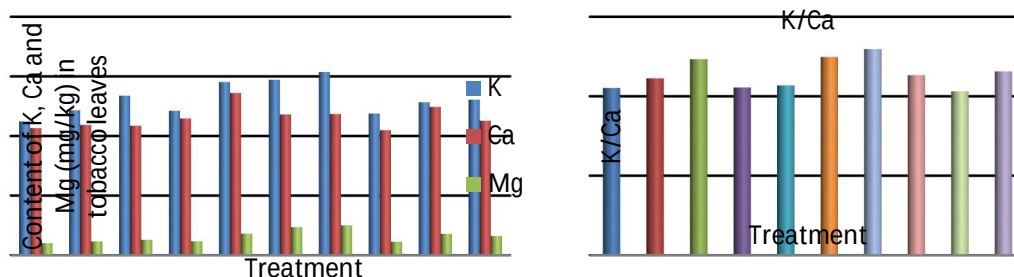


Fig. 2. Effect of organic amendments on uptake of macronutrients in Oriental tobacco leaves

Magnesium concentration in mature leaves of control was 0.40% (Table 2). The minimum content of magnesium in tobacco leaves, which do not appear symptoms of failure is about 0.25% (Vologradskij, 1971; Tso, 1989)

Campbell (2000) found that the concentrations of magnesium in both young and mature leaves are between 0.2 – 0.6%. Yancheva (2002) also reports that the magnesium content in the mature leaves of Oriental tobacco is changed within narrow limits – from 0.33 to 0.69% and it mainly depends on the arrangement of the leaves on the stem. Such limit values ranging from 0.25 to 0.85% for the concentration of magnesium in tobacco leaves during different phases of development are recommended by Jones et al. (1991).

Mg deficiency may be expected to occur when the value in the leaf is 0.2 % or less of the dry weight (McCants and Woltz, 1967). It normally occurs on sandy soils low in exchangeable magnesium, on a few acid soils low in exchangeable magnesium, or can be induced by high levels of potassium (Wild, 1988). Observed values in our experiment were higher than the critical concentration of 0.2%. The good supply of plants with Mg was probably because tobacco was grown on a soil with adequate levels of available magnesium. Organic amendments increase the content of magnesium in tobacco leaves (up to 0.51% for variants with 7.5% compost, 0.99% for variants with 10% vermicompost and 0.71% in the variants with 7.5% peat). A positive correlation between the content of potassium and magnesium in the leaves of tobacco was found. The concentration of magnesium in tobacco leaves increases with increasing content of K in the leaves. The obtained results not confirm the findings of Mylonas et al. (1981) that magnesium concentration in oriental tobacco leaves tended to decrease as applied potassium increased.

Ratio K / Ca

The ratio K / Ca is important for the quality of the tobacco raw material and it is mainly related to the structure of tobacco leaf and burn well. When calcium predominates over potassium gets raw material with poor elastic properties and volume. Our results showed that K content in tobacco leaves prevails over the content of Ca. The ratio K / Ca in control tobacco plants is 1.05. Adding organic amendments to the soil leads to increased content of potassium and calcium, the ratio K / Ca is maintained and some of the options increased to 1.23 (7.5% compost), 1.29 (10% vermicompost) and 1.15 (10% peat) (Fig.2)

3.3. Effects of organic amendments on chemical characteristics of dried tobacco

In Table. 3 are shown the results for the impact of organic amendments on chemical parameters (ash content, sugars and total nitrogen).

Table 3. Chemical composition (%) of dried tobacco leaves, variety Krumovgrad 90

Variants	Ash	Reducing sugars	Proteins	Number of Schmuk
Control	14.2	22.30	7.35	3.00
5 % compost	8.43	19.00	7.70	2.50
7.5% compost	17.7	16.66	7.55	2.20
10% compost	15.5	17.82	7.41	2.40
5% vermicompost	19.9	13.44	8.96	1.50
7.5% vermicompost	22.7	4.12	16.28	0.25
10% vermicompost	22.5	3.21	18.81	0.17
5% peat	13.9	23.69	6.85	3.50
7.5% peat	17.5	18.36	10.76	1.70
10% peat	17.6	13.54	9.66	1.40

Organic amendments influence on performance, determining the quality of tobacco - ash, protein and reducing sugars. Applications of the soil organic amendments leads to increased mineral substances (pure ash) and the amount of proteins and reduces the amount of reducing sugars in tobacco leaves compared with the control.

3.3.1. Ash

The mineral substances do not have a direct impact on the properties of tobacco smoking as burning only negligible amounts pass into the smoke. The total content of mineral substances (ash) has a significant correlation with with the fleshiness of tobacco leaves, and their quality. The ash content in dried leaves of the oriental tobacco ranged from 12% to 15% (Ghiuselev, 1983). The increase of the ash content compared to control is highly expressed in the introduction of vermicompost and peat in the soil. With the increasing amount of amendments the ash content is increasing, as the variants with 10% vermicompost reaches 22.47%, while with addition of peat to 17.63%. The influence of compost on the contents of the ash is not one-way. Higher ash content was taken into account in the variants with the addition of 7.5% and 10% compost – 17.69% and 15.51%, respectively. A weak decrease in the variant with 5% compost was observed (8.43%).

Relationship has been found between the content of potassium and magnesium in the leaves of tobacco and the ash content. With the increasing amounts of macroelements increases the ash content was observed.

3.3.2. Protein substances

The influence of the protein substances on the qualities of tobacco is generally negative, because the pyrolysis of proteins is derived nitrogenous substances in tobacco smoke with an unpleasant odor and

jarring taste. The correlation between the contents of proteins and the quality of tobacco is negative. In general, the more coarse and low quality tobaccos contain more protein. Too low content of protein is associated in most cases with a more neutral taste, while tobacco with full flavor has average protein content. Protein content in tobacco leaves ranges from 4 to 16%, while the Oriental tobacco reached 8.5%. Incorporation of organic amendments in the soil influences on the content of the protein. Influence the type and quantity of the amendments was observed. The increase in protein compared to the control is highly expressed in the introduction in the soil of vermicompost. With the increasing amount of the amendments protein increase, as the variants with 10% vermicompost reached to 18.81%.

The influence of peat on the protein content is not unidirectional. Higher content has been established in variants with the addition of 7.5% and 10% vermicompost. In the variants with 5% vermicompost slight decrease was observed. The introduction of the compost in the soil does not have a significant effect on the content of the protein compared to the control. The supply of nitrogen is the most important factor influencing the quality of tobacco (Ju et al., 2008; Bialis et al., 2009)).

A significant negative correlation was found between the yield and the content of proteins. The use of organic fertilizers leads to increase the content of nitrogen and nicotine in the leaves of oriental tobacco and Virginia (Bozhinova and Bozhinov, 2006; Zapryanova and Bozhinova, 2009). 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. (2008) reported that the mineralization of nitrogen itiner-late stages is an important factor influencing the accumulation of nitrogen and hence the content of nicotine in the leaves. Wang et al. (2008) 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. In oriental tobacco accumulates more nitrogen. A correlation between the content of nitrogen and nicotine in the leaves and the content of nicotine in oriental tobacco is higher in comparison with Virginia (Zapryanova and Bozhinova, 2009). Relationship has been found between the content of magnesium in tobacco leaves and the contents of protein substances. By increasing the amount of magnesium increases the content of proteins was observed.

3.3.3. Soluble carbohydrates

Oriental tobaccos contain significant amounts of reducing sugars and small amounts of protein. According to data by Ghiuselev (1983) the optimum reducing sugars' content in oriental tobacco is between 10% and 18%. The average content of soluble sugars in oriental tobacco ranges from 10 to 18 percent. At very high content of soluble carbohydrates - over 16% for Oriental tobaccos and low content of nitrogen substances gets one-sided, with insufficient completeness taste and enhances the burning.

This is due to a disturbance in the balance between the carbonyl and nitrogen substances in the smoke, resulting in distorted and harmony. The amount of soluble carbohydrates is strongly influenced by the conditions under which the tobacco is grown. Higher soil humidity and high content of potassium and phosphorus in the soil determine the accumulation of more soluble carbohydrates, while the lower humidity and the high content of nitrogen are associated with low carbohydrate content. The correlation between the amount of soluble carbohydrates and the quality of tobacco is positive. Incorporation of organic amendments in the soil leads to lowering the content of soluble carbohydrates. Influenced the type and amount of additive used to reduce the content of soluble carbohydrates compared to the control was observed in all the amendments used. The most significant is the reduction of the importation of vermicompost in the soil. With the increasing the amount of amendments soluble carbohydrates increased and in variant with 10% vermicompost reaches to 3.21%. A negative correlation between the content of potassium and magnesium in the leaves of tobacco and sugar content was found. The reducing

sugars' content tended to decrease at the increase of the content of potassium and magnesium in the leaves of tobacco.

3.3.4. Determining the quality of tobacco

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. Schmuck 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. Schmuck offers carbohydrate-protein, which is widely used for grading of tobacco under the name number of Schmuck, which is presented as a ratio between soluble carbohydrates and protein (Schmuck and Nauk, 1953). With the help of a number of Schmuck properly would be characterized the major quality categories of Oriental tobaccos. The quality of tobacco has a value above 1.0, average quality between 0.5 and 1.0, and low-quality – under 0.5. Organic amendments influence on the quality of tobacco. Adding compost to the soil does not lead to deterioration in the quality of tobacco compared to the control. Application of compost to the soil leads to obtain tobacco with high quality - less ash content, soluble carbohydrates and number of Schmuck over 1.0. Tobacco with high quality was obtained after the addition of peat, too. The introduction of 7.5% and 10% of vermicompost to the soil, however, leads to tobacco with lower quality (Schmuck below 0.5) (Table 3). In tobacco from control (without amendments) the ratio of total soluble sugar/protein is the highest and reaches 3. The ratio of total soluble sugars/protein is slightly lower in the variants with compost - 2.4. In the variants with a 7.5% and 10% of vermicompost, however, the ratio of total soluble sugars/protein is very low below 0.5, which would lead to the deterioration of the smoking qualities of tobacco.

4. CONCLUSIONS

On the basis of the results obtained we can be made the following conclusions:

1. Incorporation of organic amendments in the soil affects plant height and number of leaves formed. Incorporation of vermicompost and peat in the soil leads to an increase in the size of the leaves and to a lowering of the quality of the tobacco. The introduction of the compost is resulting in a slight increase in the size of the leaves and does not impair the quality of the tobacco.
2. The introduction of organic amendments resulting in increased uptake of macro elements potassium, calcium and magnesium, and leads to the improvement of the life status of tobacco plants, as well as to increased content of these elements in the leaves of tobacco and therefore may favorably affect burning properties of tobacco.
3. Organic amendments affect the indicators defining the quality of tobacco (ash content, protein and reducing sugars). The introduction of organic amendments to soil resulting in increased mineral substances (pure ash) and quantity of proteins, and reduces the amount of reducing sugars in tobacco leaves in relation to the control.
4. Addition of compost and peat to the soil does not impair the quality of the tobacco compared to the control. The addition of 7.5% and 10% of vermicompost to the soil, however, leads to decrease the quality of tobacco (Schmuck below 0.5).

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