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CHANGE IN QUANTITATIVE AND QUALITATIVE CHARACTERISTICS OF TOBACCO VARIETY JK-48 DEPENDING ON MINERAL NUTRITION

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ABSTRACT

Field experiments were carried out during 2005 - 2006 in Scientific Tobacco Institute -Prilep to investigate the effects of different rates of mineral fertilizers on yield and quality of oriental tobacco variety JK-48. According to the results, the best effect on the yield of JK-48 with an increase of 26.39 % has the Nutrifert fertilizer applied at 30 kg/ha. The average purchase price of tobacco, expressed in % of quality classes, was increased by only 1.34 % in the variant fertilized with 30 kg/ha NPK (8:22:20). In all other variants only insignificant decrease of tobacco quality was observed. To evaluate the fertilizers effect on investigated characters of tobacco all results were statistically processed by analysis of variance and LSD test.

Key words: mineral fertilizers, oriental tobacco JK-48, yield, qualitative characteristics

ПРОМЕНИ НА КВАНТИТЕТНИТЕ И КВАЛИТЕТНИТЕ КАРАКТЕРИСТИКИ НА ТУТУНОТ, СОРТА ЈК-48, ВО ЗАВИСНОСТ ОД МИНЕРАЛНАТА ИСХРАНА

Целта на двогодишните истражувања беше да се одреди влијанието на различни комбинации и концентрации на минерални ѓубрива врз приносот и квалитетот на ориенталската сорта тутун, ЈК-48.

Испитувањата се извршени на опитното поле од НИТП, во периодот 2005 - 2006 година.

Врз основа на добиените резултати, најдобар ефект врз приносот на тутунот е забележан кај ѓубривото Нутриферт со доза од 30 kg N/ha, при што истиот се зголемил за 26,39%. Просечната откупна цена изразена преку % на квалитетни класи е незначително зголемена за само 1,34% кај варијантата ѓубрена со NPK (8:22:20) со доза од 30 kg N/ha. Кај сите останати варијанти се забележува незначително намалување на квалитетот на тутунот.

За да се оцени ефектот на употребените ѓубрива врз испитуваните карактеристики на тутунот резултатите од испитувањата се статистички обработени со анализа на варијанса и LSD тестот.

Клучни зборови: ориентalски тутун ЈК-48, минерални ѓубриња, принос, квалитетни карактеристики

INTRODUCTION

Fertilization is one of the most important agricultural practices for ensuring a strong agricultural production. Yield and quality of oriental tobacco are closely associated with its availability to absorb nutrient elements from soil. Tobacco is particularly sensitive to the

quantities of nitrogen in soil. This very important nutrient has a positive impact on yield and quality of tobacco to a certain limit. Then, the yield can be increased but the quality of produced tobacco substantially declines. The use of larger amounts of fertilizers before planting and frequent nourishments of tobacco, after each irrigation, is a common practice that increases the quantity, but the quality is drastically reduced. In conditions of strong fertilization and higher nitrogen availability tobacco forms larger leaves with prominent nervature, rougher and thicker tissue, difficult to dry and with poor color (K. Naumovski et al. 1977), with higher percentage of nicotine and protein, reduced precentage of sugar and bad smoke properties (Atanasov D., 1965, Dimitrievic R, Tomic K., 1963, Donev H., 1976).

The effects of fertilization can be positive and negative. Controlled use of fertilizers secures safe production of crops. There are frequent cases when enormously high amounts of fertilizers are used in order to achieve higher yields. Uncontrolled use of fertilizers has a negative effect not only on tobacco quality but it also increases the production costs and has negative impact on the environment, especially on underground waters. That is why fertilization is a very complex process which should be paid serious attention.

Lately, the market has offered complex fertilizers with various formulations for a broad range of crops. Knowing that each crop has specific physiology and different needs for nutritious elements in various stages of development, choosing the right fertilizer and formulation requires a very cautious approach. So far, mineral fertilizer NPK 8:22:20 has been recommended for the process of tobacco production.

Taking these facts into consideration, testing was made of several new formulations of mineral fertilizers to study their impact on yield and quality of oriental aromatic tobacco in the producing region of Prilep.

MATERIAL AND METHODS

Studies were performed in 2005 and 2006, at the field of the Scientific Tobacco Institute – Prilep, with oriental tobacco JK - 48 and different combinations and concentrations of mineral fertilizers, as follows:

1. Ø- unfertilized check
2. NPK (8:22:20) + Ammonium nitrate for feed (36,5% N) - 30 kg N/h
3. NPK (8:22:20 + Ammonium nitrate for feed) - 50 kg N / ha
4. Nutrifert 6 (6:12:24 +2 MgO) + fertimon for feed (25% N) - 30 kg N/ha
5. Nutrifert 6 (6:12:24 +2 MgO) + fertimon for feed (25% N) - 50 kg N/ha
6. Magnifert (14:7:14 +5 MgO + microns) + fertimon for feed (25% N) - 30 kg N/ha
7. Magnifert (14:7:14 +5 MgO + microns) + fertimon for feed (25% N) - 50 kg N/ha

The experiment was set up in randomized complete block design in 7 variants, with 3 replications. Meteorological conditions during the experiment were recorded by the Meteorological station located near the experimental field of Tobacco Institute.

Soil tests were done before setting up the experiment in order to determine the agrochemical and physical properties of the soil. 50% of the total amount of fertilizer was applied before transplanting of tobacco, and the remaining 50% two weeks after, on the first digging. Each plot consisted of 5 rows, three of which for harvest and two for protection. Sedlings were planted at a spacing of 40x12 cm. All indispensable agrotechnichal and phyto-protection practices were applied during the vegetation period of tobacco.

Harvesting was carried out in six insertions, after which tobacco was sun-cured under polyethylene. To measure the yield, quality and chemical composition of tobacco 63 plants were picked from the middle rows of the experimental plots. Qualitative assessment of processed tobacco was made according to the Rules for measurement and purchase of raw tobacco. The obtained results on yield, average price and gross income were statistically processed with LSD test.

RESULTS AND DISCUSSION

Climate and soil are the most important factors that affect the yield and quality of aromatic tobaccos (Pasoski, 1980). The Prilep production area is characterized by a warm continental climate (Filiposki 1997). From meteorological factors, precipitation and air temperature play a major role in tobacco production (Georgievski, 1990). The results of our investigations on these two parameters are presented in Table 1.

Table 1. Sum of precipitation and average air temperature during 2005 and 2006

Month	Decade	Sum of precipitation, mm		Average air temperature, ^{o}C	
		2005	2006	2005	2006
May	I	16,0	17,5	15,4	11,1
	II	1,3	12,6	17,2	15,9
	III	30,5	---	17,5	20,8
	sum	**47,8**	**30,1**	**16,7**	**16,1**
June	I	27,6	10,5	16,5	14,3
	II	29,1	8,4	18,2	19,4
	III	0,1	7,0	22,1	24,9
	sum	**56,8**	**25,9**	**18,9**	**19,5**
July	I	1,9	40,5	22,5	19,6
	II	16,8	---	21,6	20,9
	III	0,6	11,6	24,3	24,4
	sum	**19,3**	**52,1**	**22,9**	**21,5**
August	I	57,9	30,3	21,3	22,6
	II	0,3	0,5	21,3	23,4
	III	21,8	2,4	20,9	21,5
	sum	**80,0**	**33,2**	**21,1**	**22,4**
September	I	1,4	---	18,8	20,0
	II	1,7	5,1	19,6	17,4
	III	4,7	17,7	15,2	15,8
	sum	**7,8**	**22,8**	**17,9**	**17,7**
Total		**211,7**	**164,1**	**19,5**	**19,4**

In 2005, the total amount of precipitation in May and September was 211.7 mm and in 2006 it reached 164.1 mm. In this period there were 40 rainy days. Sediment quantities were even higher than those required for a good quality oriental tobacco (Atanasov 1965), but the rainfall distribution was very uneven, especially in July and August when water requirements were the highest. The uneven distribution of precipitation had a strong impact on yield and quality of tobacco. Greater amounts of water after transplanting resulted in root development near the soil surface. In later phases longer dry periods appeared, followed by high temperatures which accelerated the evaporation, so that shallow tobacco root had no ability to satisfy the water requirements for normal plant growth. In dry periods, when soil nutrients are unavailable for tobacco plants, irrigation is an indispensable measure.

The temperature is major climatic factor for development of tobacco. The optimum temperature for tobacco growth is 20-30^{0} C (Atanasov 1965, Uzunoski 1985), the growing is best when the night temperatures are 18 - 21^{0} C (Hawks S., Colins W, 1994), and the best temperature for maturation is when it is not lower than 20 ^{o}C (Uzunoski 1985).

According to Georgievski (1990), mean daily temperature of 22-25^{0}C throughout the growing season is accepted as an optimum temperature equivalent, and the limit equivalents are between 18 and 30^{0}C.

During the two-year field investigations,

the mean daily and monthly temperatures ranged within the optimum values. The maximum temperature values were observed in July and August, with an average of 21.1 and 22.9^{0}C.

From the analysis of climatic conditions (Fig 1 and Fig 2) it can be concluded that dry periods which appear in the warmest months of the year have a negative impact on tobacco growth. The lack of water should be overcome by irrigation, which will reduce harmful effects on tobacco yield and quality.

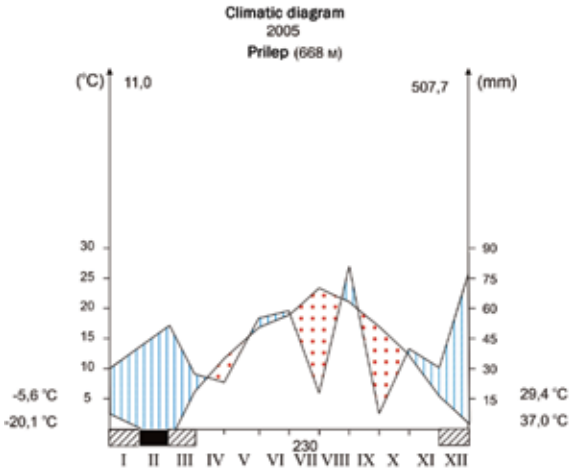

Fig. 1. Climate diagram for the year 2005

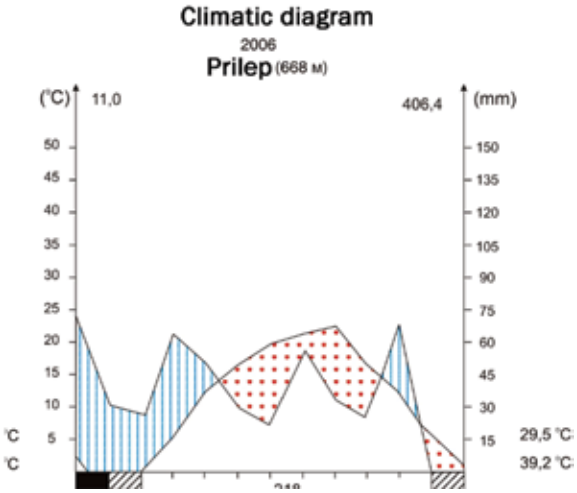

Fig. 2. Climate diagram for the year 2006

Investigations were carried out in colluvial-alluvial soil, quite common for tobacco producing region of Prilep.

According to its mechanical composition (Table 2), the soil of the arable layer is light loam, physical clay fraction is represented by 22.4%, field water capacity is 25.75% and with porosity of 31.84% it belongs to the group of low permeability soils. In terms of chemical properties, the soil is low acidic, with low humus content, low content of easily available phosphorus and medium supply of potassium.

Table 2. Physical and chemical properties of soil

Depth (cm)	Porosity vol. %	Water capacity vol. %	Fisical clay %	Texture	pH in H_2O	Humus %	mg/100 g soil	
							P_2O_5	K_2O
0 - 30	31,84	25,75	22,4	Light loam	6,00	0,53	7,3	13,3

The results on average yield (Table 3) show that all fertilized variants have higher yield compared to the check. It can be also concluded that higher yield was achieved with variants fertilized with 50 kg nitrogen/ha. The highest yield of 3353 kg/ha was obtained in variant 3, with application of Nutrifert, and in relative terms the increase was 26.39 % compared to the check.

In variant 5, fertilized with 50 kg N/ha, the yield was 25.39% higher compared to the check but 1.0% lower compared to variant 3, which was fertilized with significantly lower rate (30 kg N/ha). In variants 6 and 7 the increase was respectively 21,58% and 26,09%, compared to the unfertilized check. It can be stated from the results that the best results were obtained with

variants fertilized with 30 kg N/ha. The use of higher rates of nitrogen fertilizers is unjustified and it will only make tobacco production per unit area more expensive.

Statistical analysis of results showed significant statistical difference at 0.001 level between fertilized variants and the unfertilized check. This leads to the conclusion that all investigated formulations and rates of fertilizers have a positive effect on the yield of oriental tobacco variety JK-48. No statistical significance exists among the variants fertilized with higher rates of nitrogen, while in variants with lower rates of nitrogen statistical differences of 5% and 1% were observed. The data indicate that the investigated fertilizers Nutrifert and Magnifert gave better results compared to NPK 8:22:20, which has been commonly recommended fertilizer in tobacco production so far.

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Table 3. Average tobacco yield (kg/ha)

Variants	years			
	2005	2006	average	%
Check	2797	2509	2653	100.00
NPK 30 kg2	3258	2863	3061	115.36
NPK 50 kg3	3301	3005	3153	118.84
Nutrifert 30 kg4	3387	3320	3353	126.39
Nutrifert 50 kg5	3440	3214	3327	125.39
Magnifert 30 kg6	3356	3096	3226	121.58
Magnifert 50 kg7	3577	3114	3345	126.09

		2005 year	2006 year
LSD	0.05 =	62.19 kg/ha	101.97 kg/ha
	0.01 =	85.18 kg/ha	139.69 kg/ha
	0.001 =	116.08 kg/ha	190.36 kg/ha

Tobacco quality is expressed by the average purchase price per 1 kg of tobacco. The data presented in Table 4 show that statistical significance was observed only in variant 2, fertilized with 30 kg N/ha, with 4.43% higher average price compared to the check. In all other variants there was a decrease of tobacco quality. This means that the increase of nitrogen rates to a certain level has a stimulative effect on yield and quality, but if that level is exceeded, it has a negative impact, particularly on quality.

Table 4. Average tobacco price (den/kg)

Variants	years			
	2005	2006	average	%
Check	103.77	102.69	103.23	100.00
NPK 30 kg2	111.55	104.07	107.81	104.43
NPK 50 kg3	99.97	99.84	99.91	96.78
Nutrifert 30 kg4	101.51	102.23	101.87	98.68
Nutrifert 50 kg5	101.35	100.01	100.68	97.53
Magnifert 30 kg6	97.21	96.99	97.10	94.06
Magnifert 50 kg7	94.85	95.98	95.42	92.43

		2005 year	2006 year
LSD	0.05 =	5.70 den/kg	2.31 den/kg
	0.01 =	7.99 den/kg	3.23 den/kg
	0.001 =	11.29 den/kg	4.57 den/kg

The economic effect, expressed through monetary income (Table 5), is a synthesis between the achieved yield and the average tobacco price per unit area. It can be stated from the results that fertilization is an important agrotechnical measure which has a strong impact on the increase of tobacco yield per unit area.

High significance during the research period was observed in the increase of gross income in all variants investigated. The best economic effect was achieved in variant 4, with 24.25% higher income per hectare and in all other variants the increase ranged from 10.16% (variant 6) to 23.89% (variant 5), compared to the check.

Despite the fact that fertilization increases the costs of production, investigations have shown that this agricultural practice is still profitable investment that increases money gains to 40%.

Table 5. Gross income of tobacco for 2005 and 2006 (den/ha)

Variants	years			
	2005	2006	average	%
Check	290.065	257.497	273.781	100.00
NPK 30 kg2	363.197	298.644	330.920	120.87
NPK 50 kg3	330.695	298.508	314.602	114.91
Nutrifert 30 kg4	340.867	339.485	340.176	124.25
Nutrifert 50 kg5	348.320	330.089	339.204	123.89
Magnifert 30 kg6	324.686	278.512	301.599	110.16
Magnifert 50 kg7	336.971	267.600	302.285	110.41
	2005 year	2006 year		
LSD 0.05 =	22382.32 den/ha	12717.91 den/ha		
0.01 =	31380.45 den/ha	17830.76 den/ha		
0.001 =	44353.77 den/ha	25202.36 den/ha		

Great influence on tobacco quality has its chemical composition, in particular total alkaloids, protein, soluble sugars, mineral matter and their mutual ratio (Bajlov, Popov, 1964). The content of chemical components depends on variety, climatic conditions and, above all, on applied agricultural practices (Devcic, 1975, Beljo et al. 1994, Dimitrov 1964, Tatarcev 1955).

Table 6 presents the average values of the investigated parameters which determine the chemical composition of tobacco. The lowest content of nicotine was determined in the check (0.62%) and the highest in the variant 3 (1.15%). The content of proteins is in optimal range (Shmuk 1948) between 6.98% and 8.77%. Soluble sugars and mineral matters are also within the limits typical for this type of tobacco (Bogdanceski et co. 1997, Grabuloski 1999). The obtained results show that the applied fertilizers do not violate the harmonious chemical composition of tobacco variety JK-48.

Table 6. Chemical composition of tobacco

Variants	2005-2006			
	Nicotine %	Proteins %	Soluble sugars %	Mineral matter %
Check	0,72	6,31	18,34	9,91
NPK 30 kg2	0,94	6,54	20,27	11,70
NPK 50 kg3	1,01	6,62	20,94	10,18
nutrifert 30 kg4	1,06	6,04	22,54	11,28
nutrifert 50 kg5	1.21	6,50	20,91	11,80
magnifert 30 kg6	1,16	7,06	21,38	11,87
magnifert 50 kg7	1,29	6,50	19,95	12,37

CONCLUSIONS

Two year-investigations were carried out to study the influence of three mineral fertilizers applied in different rates on qualitative and quantitative properties of the oriental tobacco

Variety JK-48.

The results have shown that all fertilized variants have a positive impact on yield and gross income.

No statistical significance was observed among the variants fertilized with nitrogen rates up to 30 kg/ha. By further increase of nitrogen rates, the quality of tobacco decreases insignificantly.

The applied mineral fertilizers showed a positive influence on cost-effectiveness of the oriental tobacco variety JK-48.

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