www.nsseme.com/journal.html

original scientific paper / originalni naučni rad

Ratar. Povrt. 50:1 (2013) 43-48

Effect of Mineral Fertilizers Rate on Yield and Quality of the Oriental Tobacco Variety NS-72

Valentina Pelivanoska • Biljana Jordanoska

received: 26 March 2013, revised: 29 April 2013, accepted: 24 May 2013
published online: 11 June 2013

doi:10.5937/ratpov50-3656

Summary: Field experiments were carried out during 2005-2006 in Scientific Tobacco Institute, Prilep, Macedonia to investigate the effects of different rates of mineral fertilizers on the yield and quality of oriental tobacco variety Prilep NS-72. The experiment was set up as a randomized complete block design in 7 variations in 3 replications. The purpose of this research was to determine which fertilizer has the best effect on yield and quality of the investigated variety. According to the results the best effect on yield was found with application of fertilizer Nutrifert 6 (50 kg/ha), with an increase of 39.03%. The quality of tobacco is expressed in % of quality classes (I, II, III, IV). Application of 30 kg/ha NPK (8:22:20) gave an increase of 7.18% in NS-72 compared to the control. In all other variants a mild deterioration of quality was observed.
Key words: crop yield, mineral fertilizers, oriental tobacco, tobacco, quality characteristics

Introduction

Fertilization is one of the most important agricultural practices for ensuring good agricultural production. The effects of fertilization can be positive and negative. Controlled and well-dosed use of fertilizers keeps safe production of each crop. Very often, in order to achieve higher yields, fertilization is applied in enormously high amounts. Uncontrolled use of fertilizers does not only have a negative impact on products quality, but it also leads to vigorous environmental pollution, which has long term consequences on the ecosystem in general. This is why fertilization is a very complex process which deserves greater attention.

The tobacco plant uptakes large amounts of nutrients. For 100 kg/ha dry tobacco, tobacco plants uptake is around 4 kg/ha N, 2 kg/ha P_2O_5, 10.6 kg/ha K_2O and 6.3 kg/ha Ca from the soil. Knowing the quantities, it is clear that fertilization is a very important problem for quality tobacco (Atanasov 1965). According to Pelivanoska (2009) fertilization has a very important role in the tobacco plants nutrition, and nitrogen is an element that has the strongest impact on maturation, drying, yield and tobacco quality. Fertilization and irrigation are economically justified agricultural measures and must be applied for the tobacco production in the Prilep region, Macedonia (Hristoski 2006). Currently, the market offers complex fertilizers with different formulations for a broad range of crops. Given that each crop has specific physiology and different needs for nutrients in different stages of development, the selection of right fertilizer and its formulation should be approached very cautiously. So far, the NPK 8:22:20 fertilizer has been recommended for the process of tobacco production. Taking these facts into consideration, several new formulations of mineral fertilizers were tested to study their impact on yield and quality of oriental aromatic tobacco in the producing region of Prilep.

Materials and Methods

Experiments were performed in 2005 and 2006 at the field at the Scientific Tobacco Institute in Prilep, Macedonia with oriental tobacco NS-72 and different combinations and amounts of mineral fertilizers, as follows:

V. Pelivanoska* • B. Jordanoska
University "St. Klimen Ohridski"-Bitola, Scientific Tobacco Institute – Prilep, Kicevska bb, 7500 Prilep, Republic of Macedonia
e-mail: vpelivanoska@yahoo.com

1. ∅ - unfertilized control
2. NPK (8:22:20) 187.5 kg/ha+41.1 kg/ha Ammonium nitrate for top nutrition (36,5% N) - 30 kg N/ha
3. NPK (8:22:20) 312.5 kg/ha + 68.5 kg/ha Ammonium nitrate for top nutrition - 50 kg N / ha
4. Nutrifert 6 (6:12:24 +2 MgO) 250.0 kg/ha + 60.0 kg/ha Fertimon for top nutrition (25% N) - 30 kg N/ha
5. Nutrifert 6 (6:12:24 +2 MgO) 417.0 kg/ha+ 100.0 kg/ha Fertimon top nutrition (25% N) - 50 kg N/ha
6. Magnifert (14:7:14 +5 MgO + microelementts) 107.2 kg/ha + 60.0 kg/ha Fertimon for top nutrition (25% N) - 30 kg N/ ha
7. Magnifert (14:7:14 +5 MgO + microelements) 178.6kg/ha + 100.0 kg/ha Fertimon for top nutrition (25% N) - 50 kg N/ha

Experiment was set up as a randomized complete block design with 7 variations and 3 replications. Meteorological conditions during the experiment were recorded in the Meteorological station located near the experimental field of the Tobacco Institute.

In order to determine the agrochemical and physical properties of the soil, before setting up the experiment soil tests were performed. Investigations were carried out on colluvial-alluvial soil, quite common for tobacco producing region of Prilep. According to mechanical composition (Table 1), 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.

Fifty percent of the total amount of fertilizer was applied before planting of tobacco, and the remaining 50% two weeks later, on the first cultivation. Each plot consisted of 5 rows, three for harvest and two for protection. Seedlings were planted at 40 x 12 cm spacing. All indispensable agro-technical and plant 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 63 tobacco 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 (Official Journal, N° 16, 18.02.2007). The average price per kg dry tobacco was 134.75 den (2.19 EUR). The nicotine content was determined by spectrometric method (ISO 2881:2009). The protein content was determined from the nitrogen content by Kjedahl method using factor 6.25, calculated as N x 6.25 (MKS E.P3.113 Determination of proteins in tobacco). Reductive sugars were determined by Bertrand method (MKS E.P3.115 Determination of the content of reducing substances in tobacco), and the ash content was determined by dry mineralization of the organic matter, at 550°C with free access of air). 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). Precipitation and air temperature are meteorological factors that play major role in tobacco production (Georgievski 1990). The results from our investigations on these two parameters are presented in Table 2.

In 2005, the total amount of precipitation from May to September was 211.7 mm (Table 2) and in 2006 it reached 164.1 mm. In this period there were 40 rainy days. Precipitation 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

Table 1. Physical and chemical soil properties
Tabela 1. Fizičke i hemijske osobine zemljišta

Depth (cm)	Porosity vol. %	Water capacity vol. %	Physical 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

Table 2. Monthly rainfalls (mm)
Tabela 2. Mesečne padavine (mm)

Year	Month					Total
	V	VI	VII	VIII	IX	
2005	48.8	56.8	19.3	80.0	7.8	211.7
2006	30.1	25.9	52.1	33.2	22.8	164.1

Table 3. Temperature (°C)
Tabela 3. Temperatura (°C)

Year	Month					Average
	V	VI	VII	VIII	IX	
2005	16.7	18.9	22.9	21.1	17.9	19.5
2006	16.1	19.5	21.5	22.4	17.7	19.4

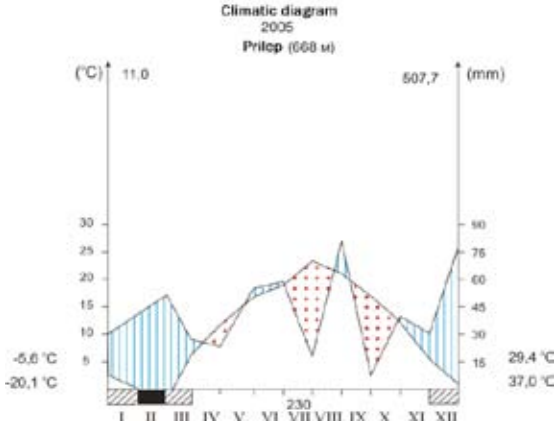

Figure 1. Climate diagram for the year 2005

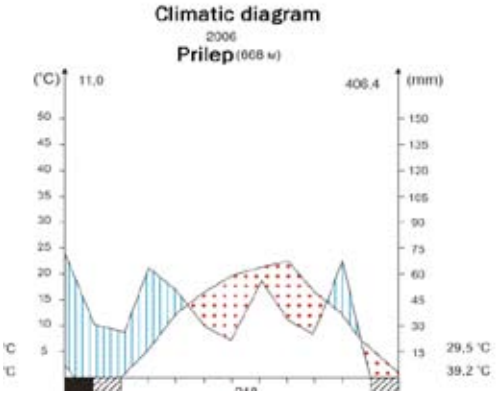

Figure 2. Climate diagram for the year 2006

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 a major climatic factor for development of tobacco. The optimum temperature for tobacco growth is 20-30°C (Atanasov 1965, Uzunoski 1985). The best growth is achieved when the night temperatures are 18-21°C (Hawks & Colins 1994), and the most suitable temperature for maturation is above 20°C (Uzunoski 1985).

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 average values of 21.1 °C and 22.9°C, respectively.

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

The results on average yield (Table 4) show that all variants with fertilization had higher yield compared to the control. It can also be concluded that higher yield was achieved with variants fertilized with 50 kg N/ha. The highest yield of 3640 kg/ha was obtained in variant 5, with application of Nutrifert, and in relative terms the increase was 39.02% compared to the control.

In variant 7, the yield was 35.79% higher compared to the control, and in variant 3 the increase was 33.73%. In variants 7 and 4, fertilized with lower nitrogen rate (30 kg N/ha), the respective yields were increased by 29.87% and 31.57%, compared to the unfertilized control.

Table 4. Average tobacco yield (kg/ha)
Tabela 4. Prosečan prinos duvana (kg/ha)

Fertilizer amounts	Years			
	2005	2006	Average	%
1. Control	2666	2571	2618	100
2. NPK - 30 kg	3460	3408	3434	131.15
3. NPK - 50 kg	3669	3334	3502	133.73
4. Nutrifert 6 - 30 kg	3337	3554	3445	131.57
5. Nutrifert 6 - 50 kg	3731	3549	3640	139.02
6. Magnifert - 30 kg	3360	3441	3400	129.87
7. Magnifert - 50 kg	3633	3478	3556	135.79
	2005	2006		
LSD 0.05 =	82.63 kg/ha	133.82 kg/ha		
0.01 =	113.18 kg/ha	183.31 kg/ha		
0.001=	154.24 kg/ha	249.80 kg/ha		

Table 5. Average tobacco price (den/kg)
Tabela 5. Prosečna cena duvana (den/kg)

Variants	Years			
	2005	2006	Average	%
Control	106.88	101.43	104.15	100.00
1. Control	118.03	105.23	111.63	107.18
2. NPK - 30 kg	100.65	97.39	99.02	95.07
3. NPK - 50 kg	111.40	106.56	108.98	104.63
4. Nutrifert 6 - 30 kg	103.33	101.27	102.30	98.22
5. Nutrifert 6 - 50 kg	98.89	97.36	98.13	94.21
6. Magnifert - 30 kg	96.28	97.38	96.83	92.97
7. Magnifert - 50 kg				
LSD 0.05 =	5.14 den/kg	1.74 den/kg		
0.01 =	7.21 den/kg	2.43 den/kg		
0.001=	10.19 den/kg	3.44 den/kg		

The analysis of results showed significant statistical difference at level 0.001 between fertilized variants and the unfertilized control. This leads to a conclusion that all investigated formulations and rates of fertilizers had a positive effect on the yield of oriental tobacco variety NS-72. No statistical significance exists among the variants fertilized with higher rates of nitrogen, while in variants with lower nitrogen rates statistical differences of 5% and 1% were observed (variant 2 compared to variant 4 and 6). The data indicate that the investigated fertilizers Nutrifert 6 and Magnifert gave equally good results as NPK 8:22:20, which has commonly been a recommended fertilizer in tobacco production so far.

Tobacco quality is expressed by the average purchase price per 1 kg of tobacco. The data presented in Table 5 show that statistical significance was observed in variant 2 with 7.18%, and in variant 4 with 4.63% higher average price compared to the control. In all other variants there was a decrease of tobacco quality. This suggests that the increase of nitrogen rates has a stimulative effect on yield and quality up

Table 6. Gross income of tobacco for 2005 and 2006 (den/ha)
Tabela 6. Bruto prihod od duvana za 2005. i 2006. (den/ha)

Variant	Years			
	2005	2006	Average	%
1. Control	284.722	262.307	273.515	100.000
2. NPK - 30 kg	407.131	360.129	383.630	140.259
3. NPK - 50 kg	369.115	329.041	349.078	127.627
4. Nutrifert 6 - 30 kg	372.564	380.020	376.292	137.577
5. Nutrifert 6 - 50 kg	376.338	365.061	370.699	135.532
6. Magnifert - 30 kg	323.769	336.760	330.265	120.748
7. Magnifert - 50 kg	343.087	333.277	338.182	123.643
	2005	2006		
LSD 0.05 =	19777.35 den/ha	10452.24 den/ha		
0.01 =	27728.23 den/ha	14654.24 den/ha		
0.001=	39191.65 den/ha	20712.61 den/ha		

Table 7. Chemical composition of tobacco
Tabela 7. Hemijski sastav duvana

Variants	2005-2006			
	Nicotine %	Proteins %	Soluble sugars %	Mineral matter %
1. Control	0.62	7.96	17.83	10.64
2. NPK - 30 kg	1.05	8.48	18.60	11.10
3. NPK - 50 kg	1.15	8.28	19.31	13.00
4. Nutrifert 6 - 30 kg	0.71	7.26	22.67	12.93
5. Nutrifert 6 - 50 kg	0.89	8.77	19.01	13.98
6. Magnifert - 30 kg	1.09	6.98	18.84	13.15
7. Magnifert - 50 kg	0.98	7.95	17.66	14.28

to a certain level, but if that level is exceeded, it has a negative impact, particularly on quality.

The economic effect, expressed through income (Table 6) 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 agro-technical measure which has a strong impact on the increase of tobacco yield (Filipovski 1989).

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 40.25% higher income per hectare, and in all other variants the increase ranged from 20.75% (variant 7) to 37.57% (variant 4), compared to the control.

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%.

Tobacco quality is greatly influenced by its chemical composition, in particular by total alkaloids, protein, soluble sugars, mineral matter content and their mutual ratio (Bajlov & Popov 1964). The content of chemical components depends on the variety, climate conditions and agricultural practices applied above all (Kozumplik 1975, Beljo et al. 1994, Dimitrov 1964, Tatarcev 1955).

Table 7 presents the average values of the investigated parameters which determine the chemical composition of tobacco. The lowest content of nicotine was determined in the control (0.62%) and the highest in variant 3 (1.15%). The protein content was in the optimum 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 (Hristoski 2006). The obtained results show that the applied fertilizers do not violate the harmonious chemical composition of tobacco variety NS-72.

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 NS-72. The results showed that all fertilized variants had a positive effect 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 decreased insignificantly. The applied mineral fertilizers showed a positive effect on the cost-effectiveness of oriental tobacco variety NS-72.

References

Atanasov, D. (1965). *Tjutjunoproizvodstvo*. Plovdiv.

Bailov, D. & Popov, M. (1965). *Proizvodsvo i prvicna obrabotka na tutunot*. Zemizdat.Sofija.

Beljo, J., Bajtek, M. & Vuletic, N. (1994). Utjecaj kolicine i rasporeda oborina na prinos i sadrzaj nikotina kod duvana tipa berlej. *Izvesce o znanstvenom i strucnom radu u 1994, 21*, Zagreb.

Dimitrievic, R. & Tomic, L. (1963). *Poznavanje duvanske surovine*. Beograd.

Donev, N. & Zlatev, G. (1974). *Tutunot vo Bugarija*. Plovdiv.

Dimitrov, D. (1964). *Dejstvie na mineralnite i organicnite torove vrhu tjutjuna*. Sofija.

Filiposki, K. (1997). *Iznaogane na ekonomski opravdan najpogoden hranidben i poliven rezim na povrsinite pod tutun od hidrosistemot "Prilepsko pole"-Prilep*, Prilep: JNU Institut za tutun.

Grabuloski, T. (1999). Vlijanie vrz kvalitetot na makedonskite orientalski tipovi tutun vrz zastapenosta na katran i nikotin vo tutunskiot cad. *Tutun/Tobacco. 49*: 119-126.

Georgievski, K. (1990). *Tutun i tutunski prerabotki- so poseben osvrt vrz ekologijata na tutunot*. Skopje: Makedonija Tabak.

Hawks, S.N. & Collins, W.K. (1994). *Nacela proizvodnje virginiskog duhana*. Zagreb.

Hristoski, Z. (2006). *Vlijanieto na nekoi agrotehnicki merki vrz kvantitativnite I kvalitativnite karakteristiki na pet sorti tutun od tipot prilep*. Master's thesis. Institut za tutun, Prilep

Kozumplik, D.J. (1975). Ujeti i neke karakteristike proizvodnje – Flue cured duhana u Podravini. *Tutun/Tobacco, 1*(2): 17-22.

Naumoski, K., Boceski, D., Grozdanoski, M., Karajankov, S. & Ackoski, B. (1977). *Sovremeno prozivodstvo na tutunot*. Skopje.

Pasoski, D. (1980). *Vlijanie na Mg, B, Cu, Zn vrz prisnosot, hemiskiot sostav i pojavata na basara kaj tutunot od tipot prilep*. Doctoral dissertation. Skopje.

Pelivanoska, V. (2009). Kvalitativni i kvantitativni karakteristiki na sitnolisnata orientalska sorta tutun P-66. *Tutun/Tobacco, 59*(9-10): 213-219.

Shmuk, A. A. (1948). *Hemija tabaka i mahorki*. Moskva.

Tatarcev. M. (1955) Pridones za kvalitativnata vrednost na makedonskite izvozni tutuni i nivnata hemiska karakteristika. *Tutun/Tobacco, 3*

Uzunoski, M. (1985). *Proizvodstvo na tutun*. Skopje.

Uticaj doza mineralnog đubriva na prinos i kvalitet orijentalnog duvana sorte NS-72

Valentina Pelivanoska • Biljana Jordanoska

Izvod: Poljski ogled je izveden tokom 2005-2006 u Naučnom institutu za duvan u Prilepu, Makedonija u cilju ispitivanja uticaja različitih doza mineralnog đubriva na prinos i kvalitet orijentalnog duvana sorte Prilep NS-72. Ogled je postavljen u potpuno slučajnom blok sistemu u 7 varijanti sa tri ponavljanja. Cilj ovog istraživanja je bilo određivanje vrste đubriva koja ima najbolji uticaj na prinos i kvalitet ispitivane sorte. Prema rezultatima, najbolji uticaj na prinos, uz povećanje od 39,03% imalo je đubrivo Nutrifert 6 primenjeno u dozi 50 kg/ha. Kvalitet duvana je izražen procentualno prema klasama kvaliteta (I, II, III, IV). Primena 30 kg/ha NPK (8:22:20) dovela je do povećanja od 7,18% sorte NS-72 u poređenju sa kontrolom. U svim drugim varijantama ogleda primećeno je blago smanjenje kvaliteta.
Ključne reči: duvan, karakteristike kvaliteta, mineralno đubrivo, orijentalni duvan, prinos