UDC 633.71
Tutun/Tobacco, Vol.54, Nº 5-6, 111-115, 2004
Institut za tutun - Prilep, R. Makedonija

ISSN 0494-3244

UDK: 633.71:581.192(497.5)
Izvoren nau~en trud

THE INFLUENCE OF FERTILIZATION WITH DIFFERENT AMOUNTS OF NITROGEN ON THE YIELD AND QUALITY OF VIRGINIA TOBACCO IN CROATIA

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1. INTRODUCTION

The main flue-cured (Virginia) tobacco area is in northern Croatia, where this tobacco type is grown on sandy soil. Nitrogen has an important role in nutrition of flue-cured tobacco, since it has strongest effect on tobacco ripening, yield and quality (1, 2, 6, 7, 8). Nitrogen mineralization from organic matter, its uptake from the soil and translocation in tobacco plants a closely related to the quantity and distribution of precipitation during the growing season (1, 6, 7, 8). In this respect, during two year period, 2000 and 2001, the influence of increasing rates of nitrogen in fertilization in agroecological conditions in Croatia on yield and quality was investigated.

2. MATERIALS AND METHODS

The trial was set up in the autumn of 1999, after the winter wheat harvest on the experimental station of the Zagreb Tobacco Institute in Pitoma?a and included five treatments:

1. Control (Ø kg N)
2. 20 kg N ha^{-1}
3. 30 kg N ha^{-1}
4. 40 kg N ha^{-1}
5. 50 kg N ha^{-1}

Phosphorus and potassium rates applied in the trial were constant and amounted to 50 kg P_2O_5 and 150 kg K_2O per hectare. Stationary field trials were carried out at random block method in four replications. The size of the experimental plots was 4,4 x 20 m. The tobacco cultivar in the experimental plot was VaD. The planting interval was 110 x 45 cm. Four raws of tobacco were planted and the yield and other properties were measured on the two middle raws in each plot. Research was conducted during two vegetation periods (1999/2000, 2000/2001). The results obtained were statistically analyzed using the variants analyses.

3. RESULTS AND DISCUSSION

3.1. Soil properties

The experiments were conducted on soil that is typical for the area where tobacco is grown on about 6000 hectares in northern Croatia. According to the texture, it was sandy loam in Ap and E horizons (Table 1).

Table 1 Mechanical composition of Luvisol from experimental plot

Soil horizon	Depth (cm)	Percent of particles				Texture
		Coarse sand (2-0.2 μm)	Fine sand (0.2-0.02 μm)	Silt (0.02-0.002 μm)	Clay (< 0.002 μm)	
A_p	0-26	15	58	17	10	sandy loam
E	26-45	18	61	15	6	sandy loam
B_t	45-90	21	36	22	21	loam

Horizon E had small penetration capacity and it was compacted. It had small capacity for water in Ap horizon and small capacity for air in E horizon (Table 2).

Table 2 Physical properties of Fluvisol from experimental plot

Soil horizon	Depth (cm)	Total porosity	Water capacity	Air capacity	Bulk density gcm^{-3}
		vol. %			
A_p	15-20	48.0	33.5	14.5	1.47
E	30-35	39.6	32.0	7.6	1.57
B_t	50-55	42.3	31.0	11.3	1.51

Soil reaction was acid, content of organic matter low, and supply of available phosphorus and potassium was moderate to good (Table 3).

Table 3 Chemical properties of Luvisol from experimental plot

Soil horizon	Depth (cm)	pH in		Organic matter %	Available, mg/100 g soil	
		H_2O	KCl		P_2O_5	K_2O
A_p	0-26	4.9	4.2	1.21	12.9	23.8
E	26-45	5.6	4.6	0.38	8.6	8.4
B_t	45-90	6.0	5.0	0.41	5.4	7.1

3.2. Meteorological data

The climate conditions during tobacco vegetation have influence on the yield, especially on the quality of tobacco (1, 6, 8). According to the data obtained from the meteorological station situated in the immediate vicinity of the experimental plot, there were considerable differences in the amount and distribution of precipitation (Table 4). A precipitation of 288.5 mm was recorded during the vegetation period in 2000, and 399.6 mm in 2001. An average amount of precipitation during the tobacco vegetation period (May to September) over several years amounts to 378.4 mm. In all years there were periods of drought which were worse in the first year. No negative temperatures, i.e. no late spring or early autumn frosts were registrated during the tobacco vegetation periods.

Table 4 Meteorological data, Pitoma~a 2000-2001

Month	Year	Air temperature (°C Mean)		Insolation h	Rainfall mm	Rainy days ? 5 mm
		Max.	Min.			
May	2000	21.4	10.5	192	19.4	1
	2001	19.7	9.4	207	151.7	9
June	2000	24.3	12.5	264	26.7	3
	2001	22.0	12.3	201	59.8	5
July	2000	28.9	14.7	338	31.8	3
	2001	27.2	15.0	266	24.9	3
August	2000	27.2	13.3	298	114.9	6
	2001	25.2	14.9	215	120.6	8
September	2000	21.9	10.2	196	92.7	4
	2001	20.8	10.4	173	42.6	3
Total (V-IX)	2000			1288	285.5	17
	2001			1062	399.6	28

In the production conditions of northern Croatia, without irrigation improtant effect on chemical properties of flue-cured tobacco has the quantity and distribution of precipitation (1, 6, 7, 8). Nitrogen application (> 30 kg N ha^{-1}) resulted in a significant increase of tobacco yield (3, 5, 12). The effects of fertilization with nitrogen was evident in statisticaly significant longer and broader leaves and higher tobacco stalks in both years the experiments were carried out (Table 5).

Table 5 Some morphological properties of tobacco in dependence on fertilization with nitrogen.

Fertilization kg ha^{-1}	Height of plants, cm		Length of middle leaf		Width of middle leaf	
N - P_2O_5 - K_2O	2000	2001	2000	2001	2000	2001
Ø - 50 - 150	107.3	109.6	35.4	36.3	20.3	20.4
20 - 50 - 150	109.1	118.2	37.3	38.4	20.5	23.1
30 - 50 - 150	118.2	121.4	41.2	47.2	23.1	25.6
40 - 50 - 150	126.4	136.7	42.3	48.1	25.6	27.3
50 - 50 - 150	131.0	141.8	48.5	49.4	26.3	28.1
LSD, 5%	11.3	13.4	5.8	6.1	N.S.	4.1

Also, in both years as the rate of nitrogen increased from 0 to 50 kg N ha^{-1} yield increased (3, 4, 5, 9, 10, 11, 12). At the same time, increased fertilization from 40 to 50 kg N ha^{-1} significantly decreased the leaf quality (Table 6).

Table 6 Effect of nitrogen fertilization on the yield and quality of flue-cured tobacco, 2000-2001

Fertilization	Yield kg ha^{-1}		Quality index	
N - P_2O_5 - K_2O	2000	2001	2000	2001
Ø - 50 - 150	1980	2030	100	100
20 - 50 - 150	2010	2080	105	108
30 - 50 - 150	2360	2160	126	121
40 - 50 - 150	2483	2380	93	89
50 - 50 - 150	2536	2410	77	68
LSD, 5%	354	286	14	17

Also, with the increased fertilization with nitrogen (> 40 kg N ha^{-1}), the content of nicotine increased and the content of reducing sugars decreased (4, 5, 8, 11).

Table 7 Effect of nitrogen fertilization on the content of nicotine and reducing sugars in tobacco leaves

Fertilization	Nicotine %		Reducing sugars %		S/N ratio	
N - P_2O_5 - K_2O	2000	2001	2000	2001	2000	2001
Ø - 50 - 150	1.73	1.84	21.31	20.04	12.5	10.9
20 - 50 - 150	1.70	1.93	19.17	18.17	11.3	9.4
30 - 50 - 150	1.96	2.01	17.03	18.16	8.7	9.0
40 - 50 - 150	2.13	2.36	14.17	15.03	6.6	6.4
50 - 50 - 150	2.77	2.81	12.06	13.14	4.3	4.7
LSD, 5%	0.17	0.21	3.17	2.13		

Furthermore, the associations of higher content of nicotine and total nitrogen, and conversely, of lower content of reducing sugars in dried tobacco leaves by increasing the rates of fertilizer, are well established. Leaves with excess N are chemically inbalanced, especially the sugar/nicotine ratio (1, 2, 4, 8).

4. CONCLUSION

In both years increased fertilization rate resulted in higher tobacco yield. Rates over 40 kg N ha^{-1} significantly decreased the leaf quality.

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