Eurasian Journal of Soil Science

Journal homepage : http://fesss.org/eurasian_journal_of_soil_science.asp

Influence of soil properties on yield and quality of tobacco plant in Akhisar region of Turkey

Sezai Delibacak [a,*], Ali Rıza Ongun [a], Sıdıka Ekren [b]

[a] Ege University, Faculty of Agriculture, Department of Soil Science and Plant Nutrition, İzmir, Turkey
[b] Ege University, Faculty of Agriculture, Department of Field Crops, İzmir, Turkey

Abstract

The research was carried out in Akhisar environs where tobacco was very popular in the period of 2004-2005. In this study, 9 fields were selected which are known to show differences in terms of the quality and efficiency in the villages called Hacıosmanlar Arabacıbozköy, Dereköy, Mecidiye and Süleymanlı. In order to find out the differences caused by the efficiency, the some properties of soils were examined. The relationships between yield and quality of tobacco and some soil properties were determined by correlation tests. After two years of the study, total alkoloid (nicotine), total reducing sugar, total nitrogen, and raw ash were measured as 0.126-1.410%, 7.81-33.71%, 0.45-3.24 %, 8.49-30.01%, respectively. The yield and total reducing sugar were decreased by increasing bulk density as an important soil property. On the other side raw ash content of tobacco increased. It is recommended that low raw ash and high sugar content are required for tobacco quality. With this content, The yield and quality of tobacco can increase with taken some necessary measurement for decreasing bulk density. The nicotin content of tobacco increased with increasing available Mg, Na and Cu content in soil. On the other side, the raw ash content in tobacco decreased with increasing total salt and available Fe, Zn and Mn in soil. It was determined that there was a positif relationship between salt in soil and reducing sugar in soil which is another quality factor for tobacco. In the research, some results were reached as mentioned above. However, further studies must be carried out in the next years to determine relationships between soil properties and yield and quality of tobacco. It can be possible to improve yield and quality of tobacco with using these relations for producers.

Article Info

Received : 18.07.2014
Accepted : 17.10.2014

Keywords: Tobacco, Soil Properties, Quality, Yield, Akhisar

Introduction

It is known that Virginia type of tobacco accounts for 60 % of theglobaltobacco production; while Burley type of tobacco accounts for 13,6 %, dark coloured and cigar tobaccos constitute 11,3 %and Oriental type of tobacco accounts for 10 % of total global production. It is also known that 40 % of Oriental type of tobacco production is occured in Turkey; among tobacco-producing countries and Oriental type of tobacco producing countries, Turkey is the 6th and 1st most tobacco-producing country by quantity, respectively (Anonymous, 2002). Aegean Region tobaccos which are called as Aegean tobaccos in international market, constitute 60-65 % of Turkey's total tobacco production. These tobaccos account for 79 and 83 % of Turkey's exportation by quantity and by worth, respectively.

According to Wolf (1962), quality of a tobacco is a result of leaf's chemical compounds and thesecompound's interactions. By doing analyses of sugar, nicotine, raw ash, protein and total N of tobacco, it is possible to determine quality to a certain extent (Akechurst, 1970; Sekin, 1979). Bürün et al. (1993) who investigated the relationships between chemical compounds and soil properties of Bitlis tobaccos, determined a

* Corresponding author.
Ege University, Faculty of Agriculture, Department of Soil Science and Plant Nutrition, 35100 Bornova İzmir, Turkey
Tel.: +902323112653 E-mail address: sezai.delibacak@ege.edu.tr
ISSN: 2147-4249

significantly positive relationships between alkaloid content and K and total soluble salt content of soils. They also determined a significantly negative relationship between hygroscopic moisture content and soil pH.

Müftüoğlu (1981) stated that, altough Turkish tobaccos grow better and become more qualified in weak soils, it is important to fertilize them scientifically. Also according to some other researchers, in productive bottom lands, tobacco yield increases but tobacco quality decreases (İncekara et al., 1977). Tuncay etal. (1985) investigated relationships between soil properties and tobacco quality. They stated that there is no significant relationship between tobacco quality and soil's N, P, K and organic matter content; on the contrary, they determined a significant relationship between tobacco quality and soil's micro nutrient content and physical properties. Peksüslü and Gencer (2001) informed that average reducing sugar, nicotine, total N and chlorine contents of Aegean Region tobaccos are 21.76 %, 0.66 %, 1.40 % and 0.48 %, respectively.

Turkish tobaccos which are used due to their low nicotine rate and their intense flavour, constitute following four groups according to their production areas; Izmir Region, Black Sea Region, Marmara-Thracian Region and East-Southern East Region (İncekara, 1979; Otan and Apti, 1989).

Aegean Region tobaccos has always retained their position in world marketfor their use in cigarette blends with respect to blend's smoking quality and they also known as İzmir tobaccos in foreign markets. These tobaccos has very low nicotine and N contents and high sugar substance content. When tobacco blends mixed with a small amount of them, they improve smoking quality. While their average nicotine content is below 0.70 %, it can decrease to 0.25 %. Their protein N contents ranges between 0.90 and 1.30 %; their reducing sugar contents ranges between 15-20 %.

Material and Methods

Material

In the year 2004, 36 soil samples were taken from 9 pedon opened in the fields of 5 different villages and 9 farmers field which are chosen for research project. Second sampling was done in 2005 and samples were taken from tillaged top layers of soils which are tobacco's effective root depth intensified in 9 samples. Also 9 tobacco samples were taken from 5 different villages and 9 farmers field.

Location of Research Area

The research was conducted at 5 different villages including Hacıosmanlar, Dereköy, Arabacıbozköy, Mecidiye and Süleymanlı with 9 different tobacco farmers in Akhisar, Manisa, Turkey in the years 2004-2005.

Akhisar, the biggest district in Aegean Region, is in the middle of Akhisar Plain with anareaof 2500 km^2 extending in a north-south direction. Akhisar district's altitude generally ranges between 60-100 m. 10 % of Turkey's total tobacco production is carried out in Akhisar. Study is conducted on soils which are used for producing high yield-high quality, high yield-low quality, low yield-high quality and low yield-low quality tobaccos. Villages, field number of villages and their symbols are given in Table 1. These villages have similar properties from the point of tobacco production, however they have some differences about sowing time and cultural practises.

Table 1. Village names, field numbers and their symbols inresearch area

Hacıosmanlar	Arabacıbozköy	Dereköy	Mecidiye	Süleymanlı	Total: 5
3 (H/1; H/2; H/3)*	2 (A/4; A/5)	1 (D/6)	1 (M/7)	2 (S/8; S/9)	Total: 9

Method

Soil Analyses

Particle size distribution of experimental soil was determined by the Bouyoucos hydrometer method (Bouyoucos 1962); bulk density was determined from undisturbed soil samples that were taken by using a steel cylinder of 100 cm^3volume (Black, 1965); total silt+clay, nonaggregated silt +clay and structure stability index (SSI) were calculated by formula (U.S. Soil Survey Staff, 1951); total water soluble salts determined according to U.S. Soil Salinity Lab. (1954); pH determined in soils saturated with water (Jackson, 1965); $CaCO_3$ determined according to Schlichting and Blume (1966); organic matter content determined according to Rauterberg and Kremkus (1951); total N determined according to Bremner (1965); available P

by Bingham method, available K, Ca, Mg and Na determined by1 N NH4 OAc (pH:7) method (Kacar, 1995); available Fe, Cu, Mn and Zn was determined by DTPA method (Lindsay and Norvell, 1978).

Methods of Chemical Analyses of Tobacco Samples

Tobacco samples were taken from tobacco bales of each farmers. Samples were grinded for chemical analyses and preserved in refrigerator. Tobacco samples analysed for raw ash (Nelson, 1960); total alkaloids (nicotine) (Anonymous, 1965); total reducing sugar (Lindsay, 1973) and total N (Kacar, 1972). Tobacco yield determined by weight of total dry tobacco leaf from decare.

Statistical Analyses

Data were analyzed for determining correlations between them by using the Statistical Package for the Social Sciences (SPSS) version 9 (SPSS, 1999)

Results and Discussion

Total Alkaloid Content (Nicotine) of Tobacco

Total alkaloid contents of dry leaf samples of tobaccos that are produced in different villages and fields, are given in Table 2. In this study that carried out in the years 2004-2005, nicotine contents have ranged between 0.131-1.114 %. These values adjust with nicotine content of Aegean Region tobaccos (Akehurst, 1970; Sekin, 1979; Collins and Hawks, 1993; Tso, 1990). When considering differences between years, nicotine values of the second year are found higher than the first year. While the highest nicotine value of the year 2004 was 0.861%, highest value of second year is determined as 1.114 %. Nicotine content of tobaccos that are produced in Süleymanlı and Mecidiye villages are found higher than other three villages due to their bottom land structure, more intensive irrigation and fertilization. The lowest nicotine content of first year was determined in Arabacıbozköy (0.131 %), and the highest nicotine content was determined in Süleymanlı(0.861%). In second year, similarly, the lowest nicotine content was determined in Arabacıbozköy(0.271%), and the highest was in Süleymanlı (1.114%). Nicotine content of tobaccos produced in Hacıosmanlar which has praire soil structure and producing qualified tobaccos, were not very low in each year. The reason of high nicotine contents that plant has to struggle to reach water and nutrients due to village's non-productive and superficial soils, this means that plant has to develop a strong root structure; nicotine that represents %95 of total alkaloid content of tobacco, are produced in roots; due to praire soil's low total leaf surface, it can easily deposit in leaves (Tso, 1972). Collins and Hawks (1993) stated that nicotine contents of Virginia type of tobaccos range between 1.5-3.5 %. Nicotine is an important quality parameter for tobacco and it needs to be neither high nor low. Abdallah (1986) underlined that, while high nicotine content adds some hardness and bitternes to taste, low nicotine content causes weak taste and physiological nonsatisfaction. Alkaloid contents of tobaccos are easily influenced by enviromental conditions and ranges between certain limits.

Table 2. Total nicotin, total reducing sugar, total N and raw ash content of tobacco samples from different villages and fields

Field number	Total nicotine (%)			Total reducing sugar (%)			Total N (%)			Raw ash (%)		
	2004	2005	Average	2004.	2005	Average	2004	2005	Average	2004	2005.	Average
H/1	0.359	0.566	0.462	32.72	24.84	28.78	0.91	1.56	1.23	8.66	15.27	11.96
H/2	0.638	0.704	0.671	30.38	24.72	27.55	1.32	1.56	1.44	13.33	13.10	13.21
H/3	0.420	0.623	0.521	27.04	22.81	24.95	1.33	1.41	1.37	12.83	11.55	12.19
A/4	0.131	0.271	0.201	23.76	32.82	28.29	0.88	1.29	1.08	19.66	20.31	19.98
A/5	0.504	0.595	0.549	27.64	27.33	27.48	1.41	1.57	1.49	16.32	19.79	18.05
D/6	0.332	0.335	0.333	23.85	24.81	24.01	1.40	1.45	1.42	17.92	18.05	17.98
M/7	0.486	0.840	0.663	19.52	23.98	21.75	1.58	2.04	1.81	20.50	18.35	19.42
S/8	0.861	0.791	0.826	26.01	25.21	25.61	1.94	1.83	1.88	15.54	17.09	22.31
S/9	0.756	1.114	0.935	23.59	14.20	18.89	2.56	2.72	2.64	17.53	20.22	18.87
Average	0.498	0.664	0.588	26.05	24.52	25.25	1.48	1.71	1.60	15.81	17.08	17.11

Total Reducing Sugar Content of Tobacco

As it is outlined in Table 2, while total reducing sugar contents of research region tobaccos was changed between 19.52-32.72 % in the first year, in the second year it was between 14.20-32.82%. Total reducing

sugar content of Hacıosmanlar and Arabacıbozköy tobaccos were higher than the other villages. When proceeding from high quality tobaccos to low quality tobaccos sugar ratio drops (Sekin, 1979). Sugar compounds provide softness in smoking tobacco and accepted as affecting quality positively (Akehurst, 1970; Tomov, 1971; Tso, 1972; Mendel et al., 1984; Abdallah, 1986). Aksu (1967) indicates, combustion products of reducing sugars of the acidic substances substantially prevents the throat burning and bitterness that alkaloids and volatile bases generate; from this aspect reducing sugars are indicated as definitely positive factor for cigarette tobaccos. Sugar content less than % 8-10 in Virginia and Oriental tobaccos is considered inadequate in terms of quality.

Total N Content of Tobacco

The amount of total nitrogen was increased from high quality to low quality tobacco. The amount of fertilizer given to the decare in the low quality group has led to an increased total nitrogen ratio in tobaccos. In both years with the group of lower quality Süleymanlı and Mecidiye villages nitrogen contents were determined higher. The difference between regions in terms of the amount of sugar was also seen in the amount of nitrogenous substances that adversely affects the quality. The difference resulting from the rural and bottom soil is also underlined by other researchers (İncekara, 1979; Wolf, 1962; Tuncay et al., 1985). Hacıosmanlar, Arabacıbozköy and Dereköy villages nitrogen amounts were lower than the other villages that ensured the high quality. According to the data obtained in two years, total N values were determined between 0.88-2.72%. Research results are similar with Sekin (1979) and Young (2001)'s findings.

Raw Ash Content of Tobacco

It is stated that ash content and quality of tobacco is in an inverse relationship (Sekin, 1979). As seen in table 2, In Hacıosmanlar village, where high quality tobaccos grown, raw ash values were determined lower than the other villages. In 2004, the ash content is less than 2005 and it is thought to be caused by the decrease of commercial quality in the second year of experiment. In this study, raw ash content values were between 8.66-20.50%. Raw ash contents of tobacco samples, taken from different parts of Aegean Region, range between 11.26-25.07% (Tuncay et al., 1985; Gencer, 2001; Salman et al., 2005). In Mecidiye village, which has bottom land, first year tobacco ash content was the highest (20.50%). The assessment made in terms of raw ash content and quality also in the second year, Hacıosmanlar village tobaccos had the lowest ash content (11.55%) were determined (Table 2). In a research conducted by Küçüközden (1995), different genotypes of Virginia type of tobacco grown in Manyas conditions, raw ash contents were ranged between values of 15,22% ile 17,93% was determined.

Tobacco Yield

Yield values of tobaccos grown in different village and farmer fields, are given in the Table 3. Highest yield was obtained 112 kg/da in the second year in Hacıosmanlar village. While yield in first year ranges between 64-108 kg/da; in the second year ranges between 51-112 kg/da. In Hacıosmanlar village, which has high first year yield and quality, average yield was determined 101.66 kg/da. In the same year, lowest yield was determined as 64 kg/da in Dereköy and Süleymanlı villages. In the second year decrease has seen in the quality values. Highest average yield was obtained with 103 kg/da in Arabacıbozköy in the second year. Lowest yield was in Dereköy with 51 kg/da with the highest quality tobaccos for that year.

Table 3. Yield values of tobaccos grown in different villages and farmer fields

Field number	2004 Yield (kg/da)	2005 Yield (kg/da)	Average yield (kg/da)
H/1	108	96	102
H/2	108	112	110
H/3	104	82	93
A/4	96	107	102
A/5	89	99	94
D/6	64	51	58
M/7	74	87	81
S/8	64	75	70
S/9	66	96	81

Some Physical and Chemical Properties and Nutrient Contents of Researched Soils of Farmers

Some physical and chemical properties and nutrient contents of researched soils of farmersare given in the Table 4.

Table 4. Some physical and chemical properties and nutrient contents of researched soils of farmers

Field number	pH		Salt (%)		OM (%)		Lime (%)		Sand (%)	Silt (%)	Clay (%)	Texture
	2004	2005	2004	2005	2004	2005	2004	2005				
H/1	7.53	7.22	0.112	0.117	1.45	1.45	20.29	32.45	37.52	28.72	33.76	CL
H/2	7.56	7.32	0.110	0.085	1.39	1.39	2.21	14.18	53.52	20.72	25.76	SCL
H/3	7.62	7.35	0.051	0.048	2.37	2.37	22.67	32.01	59.52	20.72	19.76	SL
A/4	7.78	7.78	0.051	0.051	0.93	0.93	1.72	7.98	63.28	22.00	14.72	SL
A/5	7.27	7.27	0.097	0.097	0.88	0.88	0.72	0.72	52.40	22.72	24.88	SCL
D/6	7.78	7.39	0.051	0.065	0.93	0.93	1.72	2.80	61.52	10.72	27.76	SCL
M/7	7.40	7.49	0.041	0.046	1.19	1.19	3.43	8.47	69.52	12.72	17.76	SL
S/8	7.67	7.51	0.064	0.059	1.60	1.60	11.38	10.09	55.52	22.72	21.76	SCL
S/9	7.67	7.66	0.068	0.055	0.72	0.72	15.41	15.23	45.52	26.72	27.76	SCL

Table 4. Continue.

Field number	Total siltl+clay (%)		Non aggregated silt+clay (%)		SSI		Aggregation(%)		Bulk density (g/cm^3)	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
H/1	65.44	59.20	13.44	17.20	52.00	42.00	79.46	70.95	1.02	0.98
H/2	65.44	35.20	21.44	13.20	44.00	22.00	67.23	62.50	1.00	1.57
H/3	38.32	39.20	15.20	23.20	23.12	16.00	60.33	40.82	1.12	1.24
A/4	53.20	53.20	31.20	31.20	22.00	22.00	41.35	41.35	1.09	1.01
A/5	51.76	35.20	7.76	13.20	44.00	22.00	85.00	62.50	1.28	1.11
D/6	34.32	33.20	7.20	19.20	27.12	14.00	79.02	42.17	1.22	1.17
M/7	23.76	31.20	7.76	21.20	16.00	10.00	67.34	32.05	1.33	0.95
S/8	57.76	61.20	13.76	29.20	44.00	32.00	76.17	52.29	1.13	1.22
S/9	57.76	51.20	9.76	27.20	48.00	24.00	83.10	46.88	1.16	1.31

Table 4. Continue.

Field number	Total N (%)		*P (mg/kg)		*K (mg/kg)		*Ca (mg/kg)		*Mg (mg/kg)		*Na (mg/kg)	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
H/1	0.067	0.084	0.10	0.15	252	310	2853	2866	375	255	24.90	14.94
H/2	0.067	0.045	0.09	1.29	427	272	2098	2234	300	147	19.92	9.96
H/3	0.095	0.073	0.05	0.19	97	77	3569	3489	131	81	9.96	9.96
A/4	0.101	0.056	0.37	0.30	563	446	3479	3671	427	442	9.96	19.92
A/5	0.034	0.034	0.21	0.21	456	456	1509	1509	339	339	19.92	19.92
D/6	0.050	0.062	0.01	0.19	233	272	2584	2684	224	227	24.90	19.92
M/7	0.062	0.067	0.06	2.09	174	233	1389	1200	453	617	9.96	9.96
S/8	0.067	0.073	0.02	0.76	408	408	3494	3361	673	657	69.73	29.88
S/9	0.073	0.078	0.08	0.42	398	408	3479	3479	816	794	49.81	49.81

*Available

Table 4. Continue.

Field number	*Fe (mg/kg)		*Cu (mg/kg)		*Zn (mg/kg)		*Mn (mg/kg)	
	2004	2005	2004	2005	2004	2005	2004	2005
H/1	3.77	3.85	1.64	1.54	1.66	0.86	9.50	6.64
H/2	2.50	3.85	1.60	1.30	0.76	1.12	8.62	5.17
H/3	6.26	5.18	0.76	1.06	0.58	0.58	17.32	4.12
A/4	1.83	1.95	1.20	1.36	0.86	0.76	6.56	5.65
A/5	1.83	1.83	1.16	1.16	0.72	0.72	2.06	2.06
D/6	2.16	2.61	0.94	1.14	0.48	0.68	7.14	5.15
M/7	2.19	1.62	1.12	1.46	0.68	0.76	4.50	5.87
S/8	1.47	1.43	1.80	1.92	0.62	0.60	5.90	5.01
S/9	1.67	1.60	1.82	1.70	0.64	0.58	5.80	4.57

*Available

Relationships Between Soil Properties and Tobacco Yield and Some Quality Values

Relationships between soil properties and tobacco yield and some quality values are given in Table 5.

Table 5. Relationships between soil properties and tobacco yield and some quality values

	2004	2005		2004	2005
pH-raw ash		0,583**	Fe-raw ash		-0,846**
Salt-sugar	0,670**		Cu-nicotine	0,731**	0,677**
Salt-raw ash	-0,620**		Na-nicotine	0,656**	
Organic matter-raw ash		-0,866**	Na-plant N	0,600**	0,740**
Lime-raw ash	-0,651**	-0,698**	Fe-yield	0,609**	
Sand-sugar	-0,842**		Fe-raw ash		-0,846**
Sand-raw ash	-0,830**		Cu-nicotine	0,731**	0,677**
Silt-sugar	0,791**	-0,586**	Cu-plant N		0,665**
Silt-raw ash	-0,646**		Zn-raw ash	-0,729**	
Clay-raw ash	-0,764**		Mn-yield	0,709**	0,718**

Table 5. Continue

	2004	**2005**		**2004**	**2005**
Total N-Ca	0,718**		Mn-raw ash	-0,598**	
Total N-Mn	0,617**	0,600**	Total silt+clay -sugar	0,756**	
Total N-nonaggregated silt+clay	0,732**		Total silt+clay-raw ash	0,651**	
Total N-aggregation	-0,801**		Bulkdensity-yield	-0,647**	
K- raw ash		0,654**	Bul density-sugar	-0,934**	
Mg-yield	0,700**		Bulk density-raw ash	0,839**	
Mg-nicotine	0,755**	0,688**	Yield-sugar	0,692**	
Mg- raw ash		0,646**	Yield-raw ash	-0,628**	
Mg-plant N	0,859**	0,849**	Nicotine-sugar		-0,820**
Na-nicotine	0,656**		Nicotine-plant N	0,802**	0,898**
Na-plant N	0,600**	0,740**	Sugar-raw ash	-0,924**	
Fe-yield	0,609**		Sugar-plant N		-0,826**

Conclusion

This study which researched the influence of soil properties on Akhisar region tobacco yield and quality in 2004 and 2005, was carried out in the Akhisar region, showing different yield and quality characteristics, Hacıosmanlar, Arabacıbozköy, Dereköy, Süleymanlı and Mecidiye villages. Hacıosmanlar of these villages was high in tobacco yield and quality; in Arabacıbozköy and Dereköy yield was low, quality was high. In the village of Süleymanlı, yield was high, quality was low. In the village of Mecidiye both yield and quality was low. Increasing bulk density value, one of the important physical properties of the soil, decreased the tobacco yield and sugar content of the tobacco. Also decrease in yield is determined. In contrast, raw ash content of tobacco has increased. In terms of tobacco quality, high sugar content, low raw ash content is desired. According to this, with preventions reducing the bulk density value in the tobacco soils, tobacco yield and quality can be increased. Increasing available Mg, Na and Cu content of tobacco increased nicotine content of tobacco. Quality of tobacco is influenced negatively by very high nicotine content of tobacco. Increasing salt content and available Fe, Zn and Mn content of soil decreased raw ash content of tobacco. Raw ash, one of the quality parameters of tobacco, is required to be low. Between salt in soil and sugar content which is one of the other quality parameter of tobacco, a positive relationship was determined.

In this study, some results were achieved as indicated above. Then such studies can be made in more detail, tobacco soils, tobacco quality and yield relationships can be discovered. By using these relationships, preventions that increase farmer's tobacco yield and quality can be provided.

Acknowledgements

This study was produced from Ege University scientific research Project number 2004 ZRF 028. We would like to thank Ege University Scientific Research Projects Commission for providing financial support.

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