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Research
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Research of some biological properties of agricultural soils of Bafra Plain*

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Abstract

In this research, 40 soil samples were taken from Bafra Plain, which is one of the two important plains for Black Sea Region, in September 2006, in order to specify the current conditions of the microbiological and biochemical soil characteristics in such a way that they would represent the territory in general. In these soil samples, some enzyme analyzes (acid phosphates, alkaline phosphates, β-Glucosidase, dehydrogenase, urease, and protease enzyme activities), CO_2-production, microbial biomass-C, N-mineralization, some physical and chemical analyzes (soil texture, % $CaCO_3$, pH, % total salt, organic matter) were determined and amounts of the available nutrient (P, K, Fe, Cu, Zn and Mn) were also analyzed.

According to the results of the statistical analyzes; organic matter was significantly correlated with all microbiological parameters except protease enzymes activity,

As a result In terms of decreasing the negative effect of decomposition rate of the organic matter, the sustainability of the organic matter will be possible through the incorporating into the soil of plant wastes in soil.

Key words: Bafra Plain soils, enzyme activities, CO_2-production, microbial Biomass-C.

Bafra Ovası tarım topraklarının bazı biyolojik özelliklerinin araştırılması

Öz

Bu araştırmada Karadeniz Bölgesi için önemli iki ovadan biri olan Bafra Ovası tarım topraklarındaki mikrobiyolojik ve biyokimyasal toprak özelliklerinin mevcut durumunu belirlemek amacı ile 2006 Eylül ayında araziyi temsil edecek şekilde 40 adet toprak örneği alınmıştır. Bu toprak örneklerinde enzim analizleri (asit fosfotaz, alkalin fosfotaz, β-Glukozidaz, dehidrogenaz, üreaz ve proteaz enzim aktiviteleri), CO_2-oluşumu, mikrobiyal biyomas-C, N-mineralizasyonu, bazı fiziksel ve kimyasal analizler (toprak tekstürü, %$CaCO_3$, pH ,% toplam tuz, rganik madde) ve alınabilir element miktarları (P, K, Fe, Cu, Zn ve Mn) da belirlenmiştir.

Yapılan istatistiksel analiz sonuçlarına göre organik madde miktarının proteaz enzimi, dışında bütün mikrobiyolojik kriterler ile korelasyon göstermekte olduğu tespit edilmiştir.

Sonuç olarak; topraktaki organik madde ayrışma hızının olumsuz etkisini azaltmak bakımından hasat sonrası toprak kalan bitki artıklarının toprağa karıştırılması yolu ile organik maddenin devamlılığının sağlanabilmesi mümkün olacaktır.

Anahtar kelimeler: Bafra Ovası toprakları, enzim aktivitesi, CO_2-oluşumu, mikrobiyal biyomas-C.

Introduction

Besides the scarcity of agricultural land, the manufacturers in order to achieve greater efficiency and high quality products practice intensive agricultural activities (such as processing, intensive mineral fertilization, irrigation, agricultural chemicals, and even some wrong practices). By the time this situation not only causes fatigue and deterioration of soil properties, but also decreases in yield forces.

Enhancing soil productivity, protect and ensure the continuity as well as the successful implementation of the measures taken, features of the soil not only depend on the physical and chemical aspects but also consideration of all aspects is very important. Bafra Plain soils is a place that a small number of wide-ranging and detailed microbiological studies are taken. Aim of this study is to determine the microbiological and biochemical characteristics of the region and the importance for the region and our country is quite large.

Tobacco is primary growth product in the Bafra Plain, which is the most important plain in Black Sea Region. It is predicted that 14.5% of harvested tobacco in 2003 came from Black Sea Region (Özgüven, 2005). The other crops were corn, rice, sunflower and wheat respectively. Primarily produced legumes are bean and soybean, vegetables are chili, tomato, cucumber, eggplant, onion, potato and fruits are apple, pear, peach, cherry and sour cherry.

All produced agricultural materials are served for habitants located here. However, Bafra Plain has a potential both having product diversity and production density for satisfying the requirements of neighborhood cities. Sustainability against grooving population can be attained only by investigations on soil on this plain for identification of factors affecting productivity diversely and surmounting negative factors so detailed researches have big importance.

Materials and Methods

Bafra Plain agricultural areas have been selected as the material of this study. Soil samples were taken from the field which were the subject of agricultural activity 40 soil samples were collected from the land which were represent the agricultural land (Figure 1).

The valley of the Black Sea region is one of the two major active agricultural lands Plain Bafra 40 samples were taken at the beginning of September.

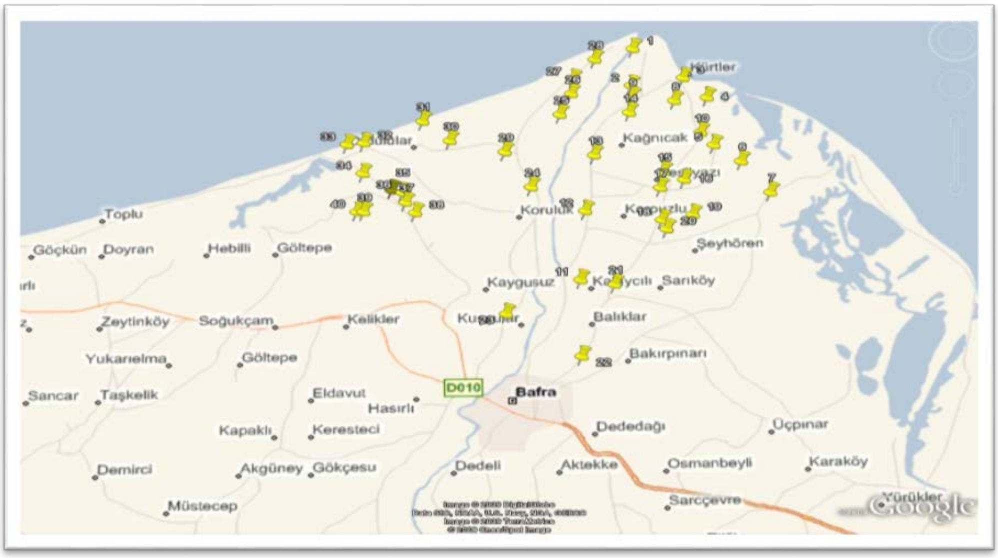

Figure 1. In soil samples taken

In analyzed soil samples; constitutive was determined according to Bouyoucos (1962), pH Jackson (1967), lime was determined according to Çağlar (1949), total N was determined according to Bremner (1960), and organic matter was determined according to Rauterberg and Kremkus (1951). All microbiological analyzes were carried out in moist soil. Soil respiration was determined according to Isermeyer (1952); microbial biomass-C was determined according to Anderson and Domsch

(1978), protease enzyme activity was determined according to Ladd and Butler (1972), dehydrogenase activity was determined according to Thalmann (1968), β-glucosidase activity was determined according to Hoffmann and Dedeken (1966), urease enzyme activity was determined according to Kandler and Gerber (1988), acid and alkaline phosphatase enzyme activity was determined according to Eivazi and Tabatabai (1977). Correlation and regression analysis of the results obtained from "SPSS 12.0" the Statistical Package Program.

Results and Discussion

Physical and chemical properties of soils that are subject of survey are also given at Table 1. Sand, clay and silt composition of the soil samples were found 26.56-97.84%, 2.16-45.44 %; 0-45.28% respectively. Texture types of 40 samples can be grouped as 39% clay loam, 22% loam and 18% sandy clay in order. Lime content varies between 0.83-15.77% and lime content in soils can be explained as 38% lime, 37% middle lime, 20% low lime. As shown in Table 1, pH values of the samples are found between 7.06 and 8.20 and it was observed that soil samples serve alkali and neutral reactions. 74% of soils are light alkali, 20% are neutral and 5% are middle alkali. Sand found in soils varies between 0.05-2.00%. Although 67% of soil samples can be counted as salt free, other part having 33% percentage is classified in salty type. Organic matter content in the soil samples are found between 0.20% and 4.170%. So 62% of samples are middle, 33% of samples are low and 3% of samples are high in organic matter content.

Table 1. Testing some of the physical and chemical properties of soils

Sample No	% Sand	% Clay	% Loam	Soil Texture	% $CaCO_3$	pH	% T.S.	% O.M.
1	38.56	22.16	39.28	loam	10.79	7.39	1.80	0.36
2	26.56	38.16	35.28	Clay loam	8.71	7.48	0.20	3.25
3	52.56	16.16	31.28	Sandy loam	15.77	7.81	0.78	0.51
4	36.56	18.16	45.28	loam	15.77	8.02	0.06	0.20
5	46.56	28.16	25.28	Sandy Clay loam	13.28	7.80	0.18	1.39
6	48.56	28.16	23.28	Sandy Clay loam	2.90	7.63	0.15	2.94
7	36.56	36.16	27.28	Clay loam	4.15	7.46	0.10	2.73
8	38.56	32.16	29.28	Clay loam	7.05	7.71	0.15	2.42
9	31.84	28.16	40.00	Clay loam	6.64	7.64	0.12	1.85
10	51.84	26.16	22.00	Sandy Clay loam	12.45	7.71	0.05	0.92
11	43.84	28.16	28.00	Clay loam	7.47	7.33	0.14	2.21
12	41.84	20.16	38.00	Loam	8.30	7.32	0.13	2.88
13	43.84	34.16	22.00	Clay loam	9.54	7.75	0.07	1.41
14	45.84	30.16	24.00	Sandy Clay loam	4.48	7.67	0.07	2.42
15	31.84	24.16	44.00	loam	12.70	7.78	0.08	1.31
16	39.84	26.16	34.00	loam	1.08	7.39	0.15	1.93
17	37.84	30.16	32.00	Clay loam	2.32	7.22	0.14	2.47
18	29.84	28.16	42.00	Clay loam	3.90	7.74	0.10	2.91
19	31.84	38.16	30.00	Clay loam	4.98	7.61	0.10	3.61
20	33.84	26.16	40.00	loam	1.24	7.62	0.10	2.47
21	36.56	29.44	34.00	Clay loam	1.08	7.24	0.11	2.21
22	42.56	15.44	42.00	loam	0.83	7.06	0.05	2.19
23	36.56	25.44	38.00	loam	9.13	7.36	0.07	2.54
24	42.56	27.44	30.00	Clay loam	9.96	7.45	0.10	2.99
25	48.56	27.44	24.00	Sandy Clay loam	6.18	7.47	0.11	1.44
26	38.56	27.44	34.00	Clay loam	8.52	7.48	0.13	3.04
27	34.56	27.44	38.00	Clay loam	8.19	7.63	0.14	4.17
28	90.56	3.44	6.00	Sandy	3.76	7.50	0.05	2.50
29	26.56	37.44	36.00	Clay loam	5.35	7.42	0.09	3.74
30	34.56	33.44	32.00	Clay loam	7.94	7.44	0.32	3.09
31	95.84	4.16	0.00	Sandy	9.61	8.20	2.00	0.46
32	97.84	2.16	0.00	Sandy	7.94	7.45	0.06	1.80
33	95.84	4.16	0.00	Sandy	8.02	7.71	0.06	1.41
34	30.92	53.44	15.64	Clay	7.52	7.76	0.09	2.01
35	50.92	25.44	23.64	Sandy Clay loam	8.19	7.60	0.15	2.50
36	32.92	45.44	21.64	Clay	4.18	7.84	0.15	2.76
37	54.92	25.44	19.64	Sandy Clay loam	8.02	7.78	0.13	2.47
38	28.92	43.44	27.64	Clay	6.60	7.71	0.15	2.14
39	48.92	21.44	29.64	Loam	5.26	7.78	0.15	1.98
40	30.92	31.44	37.64	Clay loam	7.69	7.84	0.12	2.14

O.M: Organic matter, % T.S: % Total Salt

Organic content of soil, is extremely important for the productivity and growth of plants. Organic content has many significant impact on physical and chemical properties of soil. Some of them are listed as: increasing water holding capacity of soil, providing better structure for soil, cultivating food store for plant nutrients, converting the inorganic form of plant nutrients to the organic form, stabling the changes in soil reaction by buffering feature.

According to the results enzyme activities; acid phosphates were determined between 18.07-397.00 μg p-NP/ g. dry soil/h, alkaline phosphates between 41.73-1044.61 μg p-NP/g. dry soil/h, β-Glucosidase between 2.81-200.19 μg saligenin/ g. dry soil/3h, dehydrogenase between 3.27-200.78 μg TPF/g. dry soil, urease enzyme between 3.52-57.85 μg N/g. dry soil/2h and protease between 0-192.76 μg Tyrosin/g. dry soil/2h. It was also found that amounts of CO_2-production were 6.23-36.34 mg CO_2/100 g. dry soil, amounts of microbial biomass-C were between 2.92-35.76 mg biomass-C/100 g. dry soil, and N-mineralization was between the values of 0.68-20.81 μg N/g. dry soil (Table 2).

Enzyme acid phosphatase activity was detected in agricultural soils Bafra Plain is more than the amount determined by the study of Karaca et al. (1998) Higher values of acid phosphatase of Bafra Plain than other studies, can be explained as phosphatases may be due to the generation of predominantly under conditions of low phosphorus efficacious (Okur, 1997).

The minimum value of enzyme activities in the soil samples for each enzyme was number 31. This is probably originated from due to the low content of organic matter in the soil samples. Enzyme activity in terms of organic matter is an important factor to include all enzyme substrates. Highest acid and alkaline phosphatase activities were determined in the soil sample of number 2, β-glucosidase activity and dehydrogenase enzyme activity were determined in the soil sample of number 12, urease enzyme activity was determined in the soil sample of number 2, and protease enzyme activity was determined in the soil sample 33. Each enzyme shows high activity in different substrates can be revealed this difference.

Depending on the alkaline character of the soil, it was found that alkaline phosphatase enzyme was higher. Okur et. al., (1998) found that, alkaline phosphatase enzyme activity was about 66.79-1296.51 μg p-NP/g in agricultural soil which were in the pH range of 7.4 to 8.0.

β-glucosidase enzyme has an active role in completely decomposition of cellulose to glucose and responsible for C-cycle in soil. These enzymes are found in bacteria, fungi, yeasts and plants as given in previous studies (Okur, 1997). β-glucosidase enzyme activity in the soil was found about 1.12-3.64 mg saligenin/ 100 g. dry soil in previous studies (Kızılkaya et al., 1998). In a study conducted by the territory of Bafra, β-glucosidase activity and structure, pH, EC, % moisture, % of organic matter and lime did not show a relationship between scopes (Karaca et. al. 1998)

Dehydrogenase enzyme locates in the group called intracellularly. Dehydrogenase activity of the soil is the result of several dehydrogenase activities which are the important component of all microbial enzymes such as respiration metabolism. As a consequence, dehydrogenase activity is indicator of biological redox systems and used to measure intensity of microbial metabolism (Çengel, 2004). Dehydrogenase activity were determined 132.9-658.6 μg TPF / g. dry soil in soil of Central Black Sea Region (Aşkın et al., 2004).

Urease is an enzyme that catalyzes the hydrolyzation of the urea to CO_2 and ammonia. They found higher amounts in bacteria than other microorganisms. Karaca et al. (2000) found urease activity between 34.33-58.97 mg N / 100 g. dry soil, Aşkın and Kızılkaya (2006) determined urease activity in samples taken from the Bafra Plain pasture soil between 101.0-182.7 mg N/100g. dry soil. Urease activity in soil samples investigated in this study was found lower than values given in literature.

Proteases are exo-enzymes and they are responsible to hydrolyze protein and similar materials coming from waste of animal, death edaphones and plant tissues. In this respect there is a special importance for organic materials (Çengel et al., 2007).

Table 2. Testing Microbiological and biochemical properties of soils (*g.d.s: gram of dry soil)

Sample number	Acitphosphates µg p-NP/g. d.s/h	alkaline phosphates µg p-NP/ g. d.s	βGlucosidas µg Saligenin g. d.s/3h	dehydrogenase µg TPF/ g. d.s	Urease µg N/ g. d.s ./2h	Protease µg Tyrosin/ g. d.s ./2h	CO_2production mg CO2/100 g. d.s 7days	Microbial biomass-C mg biomas-C/ 100 g	N-Min.µg N/g.k.t/day
1	224.38	783.17	83.58	81.84	28.20	59.57	24.71	24.45	6.92
2	431.94	1021.96	201.37	165.95	57.85	6.18	36.34	33.39	18.09
3	213.62	572.37	52.02	43.78	12.53	76.43	25.33	16.53	4.28
4	107.01	387.84	29.35	25.14	11.81	128.70	21.49	11.64	2.67
5	307.88	784.77	87.75	117.19	28.68	101.72	27.45	21.01	10.89
6	303.42	785.22	80.59	132.82	32.66	38.22	25.02	19.87	7.61
7	329.66	726.14	156.24	154.13	30.97	51.14	15.75	15.35	11.21
8	244.92	654.12	98.61	162.35	29.53	60.13	21.85	18.63	10.96
9	352.21	600.35	64.96	76.49	22.42	22.93	17.76	15.40	4.22
10	126.47	369.19	18.61	51.37	13.98	83.74	18.91	13.56	4.00
11	190.46	575.28	79.42	99.89	27.36	99.47	24.02	22.87	6.68
12	366.69	1028.4	200.19	200.78	49.29	164.66	26.99	26.72	10.99
13	233.85	613.74	67.66	101.07	20.85	106.22	19.27	25.55	6.96
14	255.40	683.02	90.32	134.87	30.13	47.77	31.44	29.01	9.53
15	182.45	460.97	60.61	64.34	19.89	90.48	22.70	28.50	4.86
16	214.46	410.59	62.16	103.04	28.20	17.98	14.18	20.94	4.94
17	295.22	713.51	95.97	160.29	41.58	29.22	12.59	26.20	8.58
18	303.02	836.23	105.59	134.86	38.08	63.50	26.22	34.19	11.06
19	243.96	783.07	127.79	158.98	38.81	103.41	22.59	18.85	6.52
20	331.30	684.94	63.04	105.29	17.23	4.50	19.86	28.09	7.19
21	199.78	665.90	107.67	54.85	32.39	104.53	20.49	26.36	5.91
22	262.11	489.10	71.95	40.76	26.20	121.39	8.29	12.63	4.19
23	297.07	925.92	101.21	25.61	30.69	61.82	16.63	24.22	8.46
24	294.84	556.14	85.99	43.47	28.99	110.15	19.28	29.26	10.22
25	169.72	577.39	61.39	72.49	36.88	89.92	20.62	21.54	6.91
26	246.94	728.18	93.66	25.10	32.63	1.69	27.19	21.52	13.31
27	397.00	1044.61	103.22	54.82	19.53	42.71	34.21	28.34	10.39
28	136.86	506.07	64.87	103.91	23.90	94.41	14.32	12.27	6.55
29	264.16	865.85	81.63	56.32	18.07	21.92	29.26	22.42	20.81
30	274.90	668.76	84.89	52.86	25.72	28.10	20.93	27.11	15.43
31	18.07	41.73	2.81	3.27	3.52	0.00	6.23	3.48	0.68
32	69.97	218.87	34.47	40.12	11.52	97.22	10.40	2.92	3.41
33	120.26	297.79	53.71	41.58	17.83	192.76	12.34	6.45	4.36
34	310.20	699.95	74.79	30.49	36.27	0.00	28.27	9.05	11.17
35	245.26	937.06	118.19	52.91	40.03	11.80	28.30	35.72	11.42
36	238.53	854.71	74.48	50.88	26.32	25.29	25.26	35.76	11.75
37	227.28	713.43	75.09	35.25	25.47	69.69	12.01	16.30	10.02
38	201.03	636.09	59.05	25.16	33.96	9.55	11.24	20.15	7.55
39	167.46	825.50	63.88	26.87	22.80	39.34	13.22	24.62	8.76
40	210.43	627.65	52.58	17.19	17.22	28.66	19.08	23.69	6.89

Soil samples 31 and 34 taken from Bafra Plain have no protease activity can be related to low organic matter content in these selected soils. Having low organic content causes low enzyme activity in soil. Protease is responsible for disintegrating protein during organic material decomposing. Soil sample 31 had the lowest enzyme activity for each enzyme. It can be explained that if soils have insufficient organic material and no clay, activity of soil enzymes, which are absorbed by colloided clay and humic material, are lower levels in that kind of soils.

Table 3's as can be seen from examining between alkaline phosphatase (0.391*) and dehydrogenase enzym activity were found significant positive correlations a significance level of 5%. And at the same table between the formation of CO_2 (0.660 **) and microbial biomass-C (0.712**) significant positive correlations were found the 1% significance level. Soil microbial biomass is considered to be a sensitive indicator of soil quality (Kara and Bolat, 2008).

Phosphorus uptake by plants, occurs with compounds of organic phosphorus mineralization to ortophosphate by phosphatase enzymes. (Okur, 1997) At soil samples, between acid phosphatase activity and the alkaline phosphatase enzyme (0.796**), β-glucosidase enzyme (0.744**), dehydrogenase (0.506**), CO_2-production (0.571**), microbial biomass-C (0.560**), and N-mineralization (0.619**) were significant positive correlation between the level of 1%. Because the formation of CO_2 which determined from soil samples, especially regarding the heterotrophic organisms and quality of organic matter, acid phosphatase and formation of CO_2 relation is one of the expected positive results from the results of statistical analysis (Table 3).

Table 3. Relationships between biological properties of soil samples

	Urease	Acit phosphatase	Alkaline phosphatase	β-Glukozidase	Protease	Dehidrogenase	CO_2- production	Biomass-C	N-min.
Acit phosphatase	0.656**								
Alkaline phosphatase	0.684**	0.796**							
β- glucosidase	0.841**	0.744**	0.760**						
Protease	N.S.	N.S..	N.S.	N.S.					
Dehidrogenase	0.583**	0.506**	0.391*	0.673**	N.S.				
CO_2-production	0.478**	0.571**	0.660**	0.513**	N.S.	0.330**			
Biomass-C	0.552**	0.560**	0.712**	0.518**	N.S.	N.S.	0.574**		
N-mineralization	0.576**	0.619**	0.723**	0.620**	0.322*	N.S.	0.596**	0.538**	
% Organic matter	0.494**	0.631**	0.642**	0.612**	N.S.	0.334*	0.358*	0.457**	0.689**

*: p<0.05 **: p<0.01 N.S.: Non Significant

All the features of the soil are extremely effective on events occurring in the soil. These effects microbiological properties of soil. Black Sea Region soil has a higher value than any other regions in Turkey in terms of organic content. This is because soil's low temperature, humidity and dense vegetation cover.

The soil samples are analyzed in terms of the amount of organic matter; it is found to be correlated with all other microbiological criteria except protease enzyme, the overall number of bacteria, actinomycetes and azotobacter count. This condition reveals that the soil feature is organic matter which directly effects microbiological structure of soil. On the other hand, 62% of the soil samples are sufficient, 35% is lower in organic matter conditions. In order to increase the productivity of soil, it is important to practice to increase the amount of organic matter in the soil where a low amount of organic content can be found.

In order to reduce negative impact of the speed of organic content's decomposition plant residues remaining in the soil after harvest by mixing organic matter into the soil will be able to ensure continuity.

Application of rotation of green manure crops (vetch, alfalfa, etc.) at agricultural soils of Bafra Plain will be possible to increase current microbiological activity.

Agricultural soils in Bafra Plain is under climate condition, agricultural activity, low temperatures which are the main factors diminishing the speed of organic matter decomposition that are required for soil microorganisms. Integrating plant wastes which are obtained after harvesting into the soil is important sustainability of organic matter in soil for surmounting the side effects of slow separation of organic matter.

References

Ahrens, E., 1966. Zur Der C - Quelle fürden quantitativen nachweis von azotobacter. Bodenbiologie Inst. Mitteilungsblatt Inst. Posteur, Paris, 5, 22.

Anderson, T.H., Domsch, K.H., 1978. A Physiological method for the quantitative measurement of microbial biomas in soils, Soil Biology and Chemistry, 10:215-221pp.

Bremner, J.M., 1960. Determination of nitrogen in soil by the kjeldahl method. journal of agricultural sciences, 55:11-13.

Aşkın, T., Kızılkaya, R., Gülser, C., Bayraklı, B., 2004. Ondokuzmayıs Üniversitesi kampus topraklarının bazı mikrobiyolojik özellikleri, O.M.Ü. Zir. Fak. Dergisi, 19(1):31–36.

Aşkın, T., Kızılkaya, R., 2006. Assessing spatial variability of soil enzyme activities in pasture topsoils using geostatistics, European Journal of Soil Biology, 42:230-237pp.

Bouyoucos, G.J., 1962. Hydrometer medhod ımproved for making particle size analysis of soil. Agronomy Journal Vol.54, No:5.

Çağlar, K.Ö., 1949. Toprak Bilgisi. A.Ü. Ziraat Fak. Yayınları, No:10, Ankara.

Çengel, M., 2004. Toprak mikrobiyolojisi ve biyokimyası, Ders Kitabı, E.Ü. Ziraat Fak. Yayınları No.558, İzmir, 166s.

Çengel, M., Okur. N., Irmak Yılmaz, F., 2007. Farklı organik gübrelerin çekirdeksiz üzüm bağlarında toprakların fiziksel, kimyasal, mikrobiyolojik özellikleri ile üzüm verim ve kalitesi üzerine etkilerinin belirlenmesi, Tarım Ve Köyişleri Bak. Tar. Araş. Gen. Müd. Manisa Bağ. Araş. Ens, Manisa, 97s.

Eivazi, F., Tabatabai, M.A., 1977. Phosphatases in soils. Soil Biology and Biochemistry, 9:167–172pp.

Hoffman, G., Dedekan, M., 1965. Eine methode zur koolorimertischen bestimmung der β-glucosidase aktivität in boden, z. pflanzenernaehr, Bodenkunde, 108:195–201.

Isermeyer, H., 1952. Eine einfache methode zur bestimmung der karbonate im boden, zeitschrift für planzenernährung, düngung, Bodenkunde, 56(1-3):26-38.

Jackson, M.L., 1967. Soil chemical analysis. Prentice Hall Of India Private Limited. New Delhi.

Kandeler, E., Gerber, H., 1988. Short-term assay of soil urease activity using colorimetric determination of ammonium, Biol. Fertil. Soils, 6:68–72pp.

Kara, Ö., Bolat, İ., 2008. The effect of different land uses on soil microbial biomass carbon and nitrogen in bartın province, Turk J. Agric For. Tubitak, 32: 281-288pp.

Karaca, A., Kızılkaya, R., Horuz, A., Arcak, S., 1998. Fındık tarımı yapılan toprakların biyokimyasal özellikleri ile toprak özellikleri arasındaki ilişkiler, Pamukkale Üniv. Mühendislik Bilimleri Dergisi, 4(3):813–822.

Karaca, A., Baran, A., Haktanır, K., 2000. the effect of compaction on urease enzyme activity, carbon dioxide evaluation and nitrogen mineralisation, Turk. Jour. Agric. For, 24:437-441pp.

Kızılkaya, R., Kızılgöz, İ., Arcak, S., Kaptan, H., Rakıcıoğlu, S., 1998. Microbiological properties of soils of harran plain, M. Şefik Yeşilsoy International Symposium on Arid Region Soil, 21-24 September, Menemen-İzmir-Turkey, 569-574pp.

Ladd, J. N., Butler J. H. A., 1972. Shortaemn assay of soil proteolytic enzyme activities using proteins and dipeptide derivates as substraes. Soil Biol. Biocherm., 4: 19-39.

Okur, N., 1997. Toprak enzimleri ders notları. Ege Üniversitesi Ziraat Fakültesi Toprak Bölümü, Bornova, İzmir.

Okur, N., Çengel, M., Uçkan, H.S., 1998. Microbial biomass and activity under different cropping systems, ınt. Workshop on: Improved Crop Quality by Nutrient Management, İzmir.

Özgüven, M., Sekin, S., Gürbüz, B., Şekeroğlu N., Ayanoğlu, F ve Erken, S., 2005. Tütün, tıbbi ve aromatik bitkiler üretimi ve ticareti. http://zmo.org.tr/etkinlikler/6tk05/023mensure.pdf.

Rauterberg, E., Kremkus, F., 1951. Bestimmung von gesamt humus und alkalischen humusstoffen in boden. z. für pflanzenernaehrung, düngung und bodenkunde, verlag chemie, gmbh, weinheim.

Thalmannn, A., 1968. Zur medhodik der bestimmung der dehydrogenase aktivität im boden mittels triphenyltetrazoliumchlorid (TTC), Landwirtsch, Forsch, 21:249–258.