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AMMONIUM SULFATE TRANSFORMATION RATE IN TURKEY SOILS

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Abstract

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The aim of this research conducted in the laboratory, is to determine the effect of ammonium sulfate application applied to twenty soil samples with different physical and chemical properties taken from Tekirdag region of Turkey on total mineral nitrogen and to determine the relations between ammonium sulfate transformation rate and soil properties. In the incubation test, 500 mg kg^{-1} nitrogen in the form of ammonium sulfate solution has been treated to the soil and left to incubation for 28 days. The rate of transformation of ammonium sulfate in the soil samples taken on the 1st (D1), 7th (D7), 14th (D14) and 28th (D28) days of the incubation has been determined. A significant correlation has been determined between the nitrogen loss in soil samples and the lime, magnesium and potassium content of the soils. A positive correlation in the level of r=0,457** has been determined between ammonium sulfate transformation rate (ASTR) emerged in the 7th day of the test and the lime content of the soils. In the 28th day of the test, also a positive correlation in the level of r=0,338* has been determined between ammonium sulfate transformation rate (ASTR) and magnesium content of the soils while a negative correlation in the level of r=-0,360* has been identified between ammonium sulfate transformation rate (ASTR) and potassium content of the soils. It has not been detected any significant correlation in 1st and 14th days of the test.

Key words: ammonium sulfate transformation rate (ASTR), incubation, mineral nitrogen

Introduction

Agricultural lands in our country are generally poor in organic material content (Gucdemir, 2006). According to a research carried out on the agricultural lands in Tekirdag, 90% of the soil samples were found to be inadequate by means of organic material (Belliturk and Saglam, 2005). The shortage or overage of nitrogen in soil causes a decrease in the amount and at the same time the quality of the crop. It is not possible for nitrogen fertilizers to be taken by the soil and to be stored to be used in the following years because of their chemical properties. Nitrogen is a nutrient that should be given to the soil every year (Belliturk et al.,

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2007). Nitrogen as a fertilizer is given to the soil in organic and inorganic forms. Organic nitrogen transforms firstly to ammonium salt via biological mineralization and then this transforms to nitrogen of nitrate via nitrification (Gunes and Aktas, 1992).

The mineralization rate and the amount of nitrogen gained to the soil by fertilizer material change with climate, properties of fertilizer material and soil properties such as texture, structure, porosity, pH, salt and nutrients.

The researchers who determine that approximately 76% of the nitrogen is taken back, 15.3% transforms to organic form and the remaining part is escaped from two of the soils that left to incubation adding ammonium sulfate have found that some amount of ammonium is fixed during the incubation (Broadbent and Tusneem, 1971). Similarly, in another study, the researchers have found that 5% of given nitrogen transforms to organic form, 40% of it is fixed, 40% of it is in the form of available nitrogen of ammonium and 15% of it is escaped at the end of the incubation (Broadbent and Nakashima, 1970).

In this study, the aim is to determine the nitrogen losses which are formed from ammonium sulfate fertilizer given to 20 soil samples with different physical and chemical properties taken from Tekirdag region and to determine the relationship of these rates (ASTR) with the soil properties in laboratory conditions.

Experimental

20 soil samples used in the test are taken from the depth of 1-20 cm within the limits of the province Tekirdag (Jackson, 1965). According to the meteorological data of Tekirdag region covering the average of 57 years including the year 2006, the annual average temperature is 13.9°C, annual average precipitation is 578.6 kg m^{-2}, the annual average vapor pressure is 12.7 hPa, the annual average atmospheric pressure is 998.3 mb, the annual average number of rainy day is 99.3 and the annual average relative humidity is 76.0 % (Anonymous, 2007).

Incubation Test: The test set up in the laboratory with three replications, has been conducted according to the principles declared by Saglam (1979), by mixing 10 grams of air dried soil sample (10 mesh) and 30 grams of quartz sand which was washed and sifted from 30-60 mesh sieve, with glass stirring rods, in the pots with covers which keeps the humidity under control. 500 mg kg^{-1} nitrogen in the form of solution has been added to the pots as ammonium sulfate fertilizer and the soils have been mixed properly. Than, the pots including soil samples with ammonium sulfate were covered by stretch film. The same procedures were followed for the samples of control groups which were not treated with ammonium sulfate. All the samples have been left to incubation for 28 days at 30^0C. Afterwards, the amount of mineral nitrogen {($NH_4^+ + NO_3^- + NO_2^-$) -N, mg kg^{-1}} of the soil samples of both of the two groups have been analyzed in the 1st, 7th, 14th and 28th days of the incubation. During the incubation, samples were taken after 24 hours from the ammonium sulfate treatment (D1=1st day), in the 7th day of the treatment (D7=7th day), in the 14th day of the treatment (D14=14th day), in the 28th day of the treatment (D28=28th day) and analyzed for mineral nitrogen {($NH_4^+ + NO_3^- + NO_2^-$) -N, mg kg^{-1}}.

Chemical Analysis: Bouyoucos hydrometer method is used to determine the textures of the soil samples (Tuzuner, 1990) and pH meter with glass electrodes is used to measure pH (1:2.5 soil: distilled water) (Bayrakli, 1986). Organic material of the soil samples were analyzed by Walkley-Black method (Greweling and Peech, 1960), the salinity was measured (1:2.5 soil: distilled water) by electrical conductivity instrument and exchangeable cations (Ca^{2+}, Mg^{2+}, K^+) (Saglam, 2008) by flame photometer and lime by volumetric calcimeter method (Gedikoglu, 1990). The amounts of available ammonium and nitrate were determined by vapor distillation (Kjeldahl) method as stated by Saglam (2008).

The soil samples left to incubation were taken from the oven and after taking the stretch film, 100 ml of 2 N KCl was added into the sample. Then, this pot was tightly enclosed with its original lid and shaked in a mechanical stirrer for one hour. The test pot was allowed to stand for about 30 minutes until the soil-

sand mixture has settled and the liquid above it has become clear.20 ml of the upper clear liquid were taken with a pipette with wide mouth and pour into a 500 ml distillation flask. Afterwards, mineral nitrogen {(NH_4^++NO_3^-+NO_2^-)-N, mg kg^{-1}} is determined.

Calculations and Statistical Analysis: For the calculation of the correlation coefficients between the characters, SPSS package program has been used (SPSS, 1999).

Ammonium Sulfate Transformation Rate (ASTR): ASTR has been calculated relatively from the determined amount of mineral nitrogen {(NH_4^++ NO_3^-+ NO_2^-) -N, mg kg^{-1}} by the application of ammonium sulfate according to the following equation:

ASTR (%) = [(a-b) / a] x 100,

Where;

ASTR: Ammonium Sulfate Transformation Rate, %

a: The amount of nitrogen in the form of ammonium sulfate given to the soil, mg kg^{-1}

b: Total amount of mineral nitrogen {(NH_4^++NO_3^- +NO_2^-)-N, mg kg^{-1}} in the soil determined in the 1^{st}, 7^{th}, 14^{th} and 28^{th} days of the incubation, mg kg^{-1}

Results and Discussion

The locations (as borough and village) where the soil samples are taken from and the results of some physical and chemical properties of these soils are in Table 1.

Average pH value of the soil samples used in the test is 7.25. When the % salt content of the soil samples is analyzed, all the soils are found to be "salt-free" class. $CaCO_3$ content of the soil samples vary from 0.00% to 16.80%. When exchangeable cations are analyzed, K^+ content of the soils vary from 1.80 to 11.89 me/100g , Ca^{2+} content vary from 3.33 to 40.67 me/100g and Mg^{2+} content vary from 1.17 to 21.00 me/100g. Organic material content of the soils vary from 0.69% to 2.62%. It is also determined that NH_4^++ NO_3^-+ NO_2^- values of the soil samples vary from 1.01 ppm to 7.04 ppm and the average is 3.72 ppm. When the texture classes of the soil samples are examined, it is observed that it shows a wide distribution (Table 1). It is observed that 85% of the soil samples are poor in organic material. These results resemble the results of previous studies on the soils of the region (Belliturk, 2004; Belliturk et al., 2007).

Total Nitrogen Transformations Resulting from Ammonium Sulfate Treatment

Ammonium sulfate transformation rates of each soil are given individually in Figure 1. According to the results, it is seen that the average ammonium sulfate transformation rate (ASTR) in period D1 is 32.57 %, it is 34.02 % in D7, 47.54 % in D14 and 45.64 % in D28. It appears to be the highest value is in D14 period of the incubation. As well as there is not a significant change in average nitrogen transformations obtained from the first to seventh day of the incubation, significant increases are observed in these values in the 14^{th} and 28^{th} days of the incubation. The sequence of the average mineral nitrogen values is D14>D28>D7>D1 as seen. When the transformations resulting from ammonium sulfate are considered, it is seen that there is not a regular increase or decrease parallel to the days. The variabilities arise also in nitrogen transformation rates depending on the differences of physical and chemical properties of the soils in research. The mineralization resulting from the nitrogen of ammonium sulfate is under the influence of physical and chemical phenomena occurring in the soils.

The transformation of the nitrogen of ammonium to the nitrogen of nitrate is not desired in some cases. As it known, nitrate anion does not adsorbed by soil colloids or organic complexes like ammonium cation and it is washed from the soil by rain or irrigation water easily. As a result, it causes primarily nitrogen loss or environment pollution with draining of washed nitrate to the ground water (Gunes and Aktas, 1992). According to a research done with nitrogen fertilizer in Tekirdag region, the highest loss is obtained from ammonium nitrate and ammonium sulfate fertilizers while the lowest loss is obtained from urea fertilizer (Akay, 1994).

Some amount of nitrogen may be lost with denitrification or may be lost in the form of ammonia depending on soil and climate conditions from ammo-

Table 1
The locations of the soil samples and some physical and chemical properties of the soils

Soil	Borough	Village	pH (1/2.5 H2O)	Salt, %	$CaCO_3$, %	Organic material, %	$NH_4^+ + NO_3^- + NO_2^-$, mg kg-1	Exchangeable cations, me/100g			Texture		
								Ca^{2+}	Mg^{2+}	K^+	Clay, %	Silt, %	Sand, %
1	Muratli	Arzulu	6.5	0.01	0	1.16	7.04	5.67	2.17	3.33	27.53	39.63	32.83
2	Cerkezkoy	Yanıkagil	6.57	0.01	0	1.4	3.02	3.33	3.5	4.23	18.09	14.33	67.58
3	Hayrabolu	Oreykoy	7.43	0.02	0	2.16	4.03	15.83	3.5	8.97	43.13	4.27	52.6
4	Sarkoy	Senkoy	8.01	0.03	16.8	1.65	3.02	21.33	2.83	11.89	38.02	48.05	13.93
5	Corlu	Onerler	5.4	0.01	0	0.95	7.04	5.17	1.83	1.8	8.46	10.07	81.47
6	Corlu	Marmaracik	7.82	0.01	2	0.69	2.01	20	2.83	3.19	32.19	4.24	63.58
7	Hayrabolu	Faraskoy	7.98	0.02	9.21	2.01	4.03	21.83	5.33	7.74	21.33	52.29	26.38
8	Hayrabolu	Canhidir	7.96	0.01	8.8	1.73	5.03	22.83	1.83	4.07	37.52	43.29	19.19
9	Muratli	Musellim	6.69	0.02	0	1.51	3.02	17.17	2.5	4.38	39.41	6.16	54.43
10	Malkara	Emirali	7.98	0.04	12.41	0.99	1.01	17.5	1.17	3.48	23.14	35.13	41.73
11	Merkez	Biyikali	6.74	0.01	0	1.32	3.02	16.17	6.5	4.38	38.26	35.73	26.01
12	M.Ereglisi	Yeniciftlik	7.82	0.03	2	0.98	1.01	30	1.5	3.77	25.67	46.29	28.05
13	Merkez	Inecik	8.2	0.02	7.21	1	5.03	21.5	2.83	6.41	30.1	47.54	22.36
14	Saray	Sinanli	8.22	0.02	10	1.03	4.03	40.67	4.83	8.35	37.87	34.69	27.44
15	Malkara	Kozyoruk	6.65	0.01	0	1.26	2.01	6	4.17	2.79	22.41	36.94	40.65
16	Saray	Yuvali	7.16	0.02	0	1.09	1.01	9.83	2.17	2.79	17.44	24.45	58.1
17	Muratli	K.kepenekli	6.69	0.02	1.23	1.47	3.02	21.2	3.1	4.38	39.41	6.16	54.43
18	Malkara	Kalayci	7.96	0.01	0.82	1.89	7.04	13.4	13.8	4.07	37.52	43.29	19.19
19	Corlu	Sarilar	6.57	0.01	8.17	2.62	5.03	19.8	12	4.23	18.09	14.33	67.58
20	Merkez	Gazioglu	6.74	0.01	7.36	1.89	4.03	24	21	4.38	38.26	35.73	26.01
Min.			5.4	0.01	0	0.69	1.01	3.33	1.17	1.8	8.46	4.24	13.93
Max.			8.22	0.04	16.8	2.62	7.04	40.67	21	11.89	43.13	52.29	81.47
Avg.			7.25	0.02	4.3	1.44	3.72	17.66	4.97	4.93	29.69	29.13	41.18

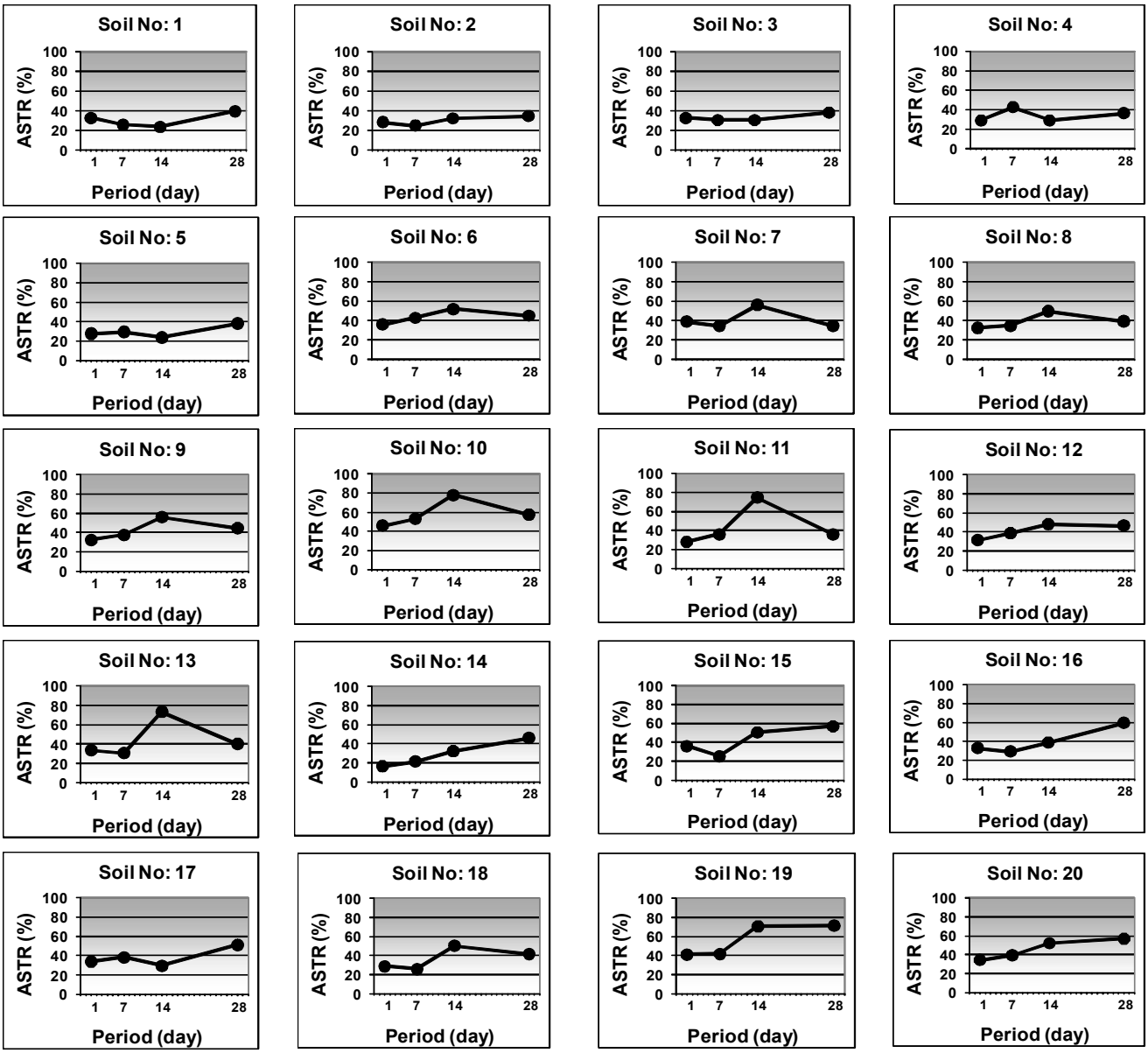

Fig. 1. Ammonium sulfate transformation rate (ASTR) of each soil in for different period of the incubation, %

nium sulfate fertilizer given to the soil. The case is easily seen in the study in which 500 mg kg^{-1} ammonium sulfate is given. According to the results, 100% value is not obtained in any of the applications, in other words, the ammonium sulfate given to the soil never completely transforms to mineral nitrogen and some nitrogen losses are observed. It is not possible to stop such kind of nitrogen losses completely. However, it is possible to decrease some amount of the nitrogen losses. The texture (clay, silt and sand fractions), organic material, lime, pH and amount of exchangeable cations of the soil may be effective on total mineral nitrogen transformations in the soils.

The relationship between total nitrogen transformations resulting from ammonium sulfate fertilizer treatment and some physical and chemical properties

and nitrogen of ammonium and nitrate of the soils is given in Table 2. When Table 2 is analyzed, a significant positive correlation between nitrogen transformation values (ASTR) and lime content of the soils is obtained (r=0.457**) in D7 period of the incubation. Some researchers state that there is not a loss in the form of evaporation from ammonium sulfate given to the soils with low pH and lime content whereas, significant losses are observed in the limy soils with high pH values (Ghildyal and Singh, 1961). The average pH value of the soil samples used in this study is 7.25 and average lime content is 4.30%. The soils used in the test are in the low lime class by means of their average lime content (Gucdemir, 2006). Thus, total mineral nitrogen transformations resulting from ammonium sulfate fertilizer increase with increasing amount of lime (Table 2). Gasser (1964) states that 7-8% of the given ammonium sulfate is lost in the form of NH_3 during the incubation, nitrogen loss resulting from ammonium sulfate is very fast and continue until all the nitrogen of ammonium undergo nitrification.

A significant positive correlation between ASTR and Mg^{2+} content of the soils is obtained (r= 0.338*) in D28, a significant negative correlation between ASTR and K^+ content is obtained (r=-0.360*). A significant correlation is not obtained in D1 and D14. Significant negative correlations are obtained between nitrogen transformations determined in D1, D7, D14 and D28 incubation periods and nitrogen of ammonium determined in the same incubation periods and nitrogen of nitrate determined in D1, D14 and D28 periods. The increase in the nitrogen of ammonium and the nitrogen of nitrate in the soils in research until D7 period depending on the incubation period is related with decomposition reaction of nitrogen in the soil. This situation resembles many previous studies on nitrogen (Bremner and Douglas, 1971; Matar and Doering, 1979; Belliturk, 2004; Belliturk et al., 2007).

When Figure 1 is examined, it is seen easily how the nitrogen transformations in each soil during the incubation is. These results resemble the previous studies (Bremner and Douglas, 1971; Belliturk, 2004; Belliturk et al., 2007). Soil properties affect the nitrogen transformations resulting from applied nitrogen fertilizers and also affect ammonia losses. Therefore, the properties of soil which the nitrogen fertilizer is applied to should be well known. This condition is obviously seen from the statistical relation between mineral nitrogen transformations (ASTR) resulting from the ammonium sulfate fertilizer and soil properties.

Approximately 50% of the nitrogen applied to the

Table 2

The relationship between total nitrogen transformations (ASTR) resulting from ammonium sulfate fertilizer treatment in different periods of the incubation and some physical and chemical properties and nitrogen of ammonium and nitrate of the soils

ASTR								
Properties of soil	Incubation period, days							
	D1		D2		D3		D4	
pH	-0.008	ns	0.175	ns	0.277	ns	-0.145	ns
CaCO3	0.148	ns	0.457	**	0.239	ns	0.092	ns
Organic Material	0.219	ns	0.073	ns	0.098	ns	0.158	ns
Ca++	-0.223	ns	0.248	ns	0.19	ns	0.095	ns
Mg++	0.029	ns	0.02	ns	0.234	ns	0.338	*
K+	-0.263	ns	0.017	ns	-0.167	ns	-0.36	*
Clay	-0.266	ns	0.086	ns	0.002	ns	-0.225	ns
Silt	-0.032	ns	-0.06	ns	0.248	ns	-0.175	ns
Sand	0.159	ns	0.008	ns	-0.212	ns	0.26	ns

soil with fertilizers is taken by the plants in the first year, 30% of it is fixed by microorganisms, 15% of it is lost via denitrification and 5% of it is lost via washing (Aydemir, 1979). These losses in nitrogen fertilizers applied to the soil mainly depend on soil properties and climate conditions. Therefore, not to fertilize the soil without knowing the properties of the soil is critically important.

Upsurge in population introduces many problems accompanied with increasing technological developments in recent years. The most important of these are inadequate nutrition, hunger, global warming, desertification and environmental pollution. Therefore new solutions against these problems are needed. Widening plantation areas in order to achieve increase in the yield is one of the solutions. However, it is not possible to open new plantation areas since already reached to natural borders of agricultural areas and rural population decreases continuously. For this purpose, increasing the opportunities to get maximum yield from unit area becomes a necessity.

As a conclusion in all regions of Turkey climate and soil features are different. Holding this kind of researches in all the region of Turkey will be useful to ensure preventing environmental pollution and loss of nitrogen.

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