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The Determination and Limitation of Ammonia Losses from Urea Fertilizers within Soils by Using Different Organic Materials

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***Abstract*— After using nitrogen fertilizers to soil a part of the nitrogen in the fertilizer losses with volatilization are important in agriculture. Sometimes the loss of level with volatilization has reach to 50 %. The purpose of this investigation is to determine nitrogen losses as NH_3 volatilization, effect of some factors on the losses and being limited some materials in soil samples. In the experiment, urea from the nitrogen fertilizers were applied to soil samples and these samples were dried in the closed system under constant air flow. In addition to this experiment, the ammonia losses from nitrogenous fertilizer (urea) were studied to limit with mixing some different organic materials (bark talk of pine (BToP), peat, straw, wood shaving) to this samples.**

Keywords—Nitrogen fertilizers, Volatilization, Organic material, Soil.

I. INTRODUCTION

Nitrogen fertilizers present high solubility and are effective for agricultural practices. Some of nitrogen in the nitrogenous fertilizers using to soil has been lost by volatilization and this losing has been reached to high levels [1] (Allison, 1955). Urea is characterized as the granulated solid nitrogenous fertilizer of highest N concentration (45 %). Among the sources of N in the world, it has lower market value and is the most used. Therefore, there is some concern regarding on its use due to the fact that its application on surface promotes N losses by volatilization in the form of $N\text{-}NH_3$. Among the advantages of urea, besides the high N concentration and low cost, one may mention the low expenses with transportation, storage and application, high solubility, low corrosive properties as well as easiness to mix with other sources [2,3,4] (Cantarella & Raij, 1986; Melgar et al., 1999; Pereira at al., 2009).

The NH_3 losing from being the urea was obtained relating with pH and other factors. In the high levels of pH urea has changed to ammonium by hydrolyzing and then been ammonium carbonate importantly [5,6,7] (Fenn and Kissel, 1975; Du Plessis and Kroontje, 1964; Terman and Hunt, 1964). Nitrogen may be from the soil in the form of gases. A considerable loss of NH_3 may occur when NH_4^+ -salts are applied to calcareous soils. Such high pH soils should not to treated with NH_4^+ -salts. The same is also true for the use of urea as a top dressing [8] (Cooke, 1972). When the nitrogen fertilizer was given to the soil NH_3 losing by volatilization has changed according to the fertilizer types and soil conditions. In addition to the matter it has appeared to increasing nitrogen level giving to the soil has been increased to the NH_3 losing. Separately, the soil texture has affected the NH_3 losing [5] (Fenn and Kissel, 1975). According to the studies of Sağlam et al. [9], loss of from urea was obtained between 9.66 and 14.44% at the level of 100 and 150 kg N/da respectively. According to the Lehr and van Wesemael [10], urea application leads to the loss of NH_3 by volatilization as it is very rapidly converted to NH_4^+ particularly in alkaline soils. This losing of nitrogen by volatilization is changed according to the $CaCO_3$ content of soil, pH, type of fertilizer, type using of fertilizer, level of fertilizer etc. The calcium carbonate content of soil is important affected factor to losing in the nitrogen fertilizer as ammonia. In general, with increasing to the $CaCO_3$ content of the soil is increase losing of nitrogen as ammonia. According to the researches, it has been obtained correlation between the $CaCO_3$ content of the soil and losing of nitrogen as ammonia It has been known that pH level effects to the NH_3 losing. On the other hand, with increasing to the reaction of soil is increased losing of nitrogen as ammonia [5].

Bark of trees mainly used as power fuel as replacement for natural fuel (oil and gas). Recently, the bark, complex chemical mixture of many organic compounds bearing a large amount of hydroxyl, carboxyl, methoxyl functional groups etc. has also been used as an environmental pollution control product, e.g., erosion controller and slope stabilizer, odor scavenger in sulfate pulp mills and oil pollutant, mulch, and soil conditioner, replacement with phenol in resolve adhesives, etc. [11, 12] (Fengel and Wegener, 1984; Alma and Kelley, 2002).

In this study, for the determination of ammonia losses it was used different organic materials (bark talk of pine: BToP, peat, straw, wood shaving) in laboratory experiment and the losses from nitrogenous fertilizers (urea, ammonium nitrate, ammonium sulfate) were determined with these organic materials to limit with mixing to this soil samples.

II. MATERIAL AND METHOD

A. The experiment with using of BToP

The soil samples were selected from 3 areas in the Pazarcık-Kahramanmaraş, Turkey in this study and were used to determine NH_3 losing by volatilization. To limitation of NH_3 losing Bark Talk of Pine (*Pinus brutia* L.) (BToP) was added to the soil at the level of 0, 5, 10, and 20%. As the nitrogen source urea fertilizer (N: 46 %) was added to the soil at the level of 0, 250, and 500 kg N/ha. In a closed system it was held air compressed to the soil+BToP+nitrogen solution mixings at 8 hours and 1 bar/minute at atmospheric pressure. Then NH_3 losing was held in the boric acid solution in the closed and air controlled system. Experimental set-up for absorption of NH_3 comprised two 500-mL conical flasks, in the first conical flask was packed soil+ure samples, and the second conical flask was filled with 50-mL boric acid solution. There was also an air source by compressor in this system for air transport and increasing volatilization of NH_3. The absorbed NH_3 in this system was determined with using 0.002 N HCl as titrimetric method. Physical and chemical analysis of 3 soils and BToP used in the study was given into the Table 1-4.

TABLE 1. pH, EC, $CaCO_3$ AND ORGANIC MATTER CONTENTS OF SOILS USED.

Soil	pH	EC	$CaCO_3$ %	O.M. %
1	8,15	0,125	26,32	2,28
2	8,02	0,100	22,07	2,14
3	8,01	0,186	4,84	1,48

TABLE 2. NUTRIENT ELEMENTS OF SOILS USED.

Soil	Na^+	K^+	Ca^{++}	Mg^{++}	P	Zn	Fe
	meq.100 g^{-1}				mg.kg^{-1}		
1	0,17	0,71	29,27	12,55	26,02	0,25	5,03
2	0,11	0,79	31,29	5,69	11,56	0,21	7,77
3	0,21	0,77	35,12	12,36	17,20	0,26	5,40

TABLE 3. PHYSICAL AND CHEMICAL ANALYSIS OF SOILS USED.

Soil	Texture			
	Sand	Loam	Clay	Group
1	23,96	26,81	49,24	C
2	21,60	35,50	46,90	C
3	17,65	19,19	63,16	C

TABLE 4. PHYSICAL AND CHEMICAL CONTENTS (%) OF BTOP.

Bark Talk of Pine (BToP)	Lignin	Ash	Carbohydrates		Extractives	Constitute of Pine
			Cellulose	Hemi-cellulose		
	23,7	3,5	35,2	19,0	18,6	10-20

B. The Experiment with Using of Straw and Wood Shaving

To limitation of NH_3 losing straw and wood shaving were added to the soil at 2 g level of organic materials. The nitrogen source urea (N: 46 %) fertilizer as 100, 200, and 300 ppm doses were mixed to 10 g soil. In a closed system it was held air compressed to the soil+straw or wood shaving+nitrogen solution mixings at 8 hours and 1 bar/minute at atmospheric pressure. Then NH_3 losing was held in the boric acid solution in the closed and controlled air system. For absorption of NH_3 experimental set-up designed with two 500-mL conical flasks, in the first conical flask was packed soil+organic material+nitrogenous solution fertilizer samples, and the second conical flask was filled with 50-mL boric acid solution to absorb NH_3 losses. There was also an air source by compressor in this system as income and outcome for increasing volatilization of NH_3. The absorbed NH_3 in this system was determined with using 0.002 N HCl as titrimetric method. The texture analysis of soils was determined as clay.

C. The Experiment with Using of Peat

An apparatus to measure ammonia losses in soil+peat+nitrogenous fertilizer (urea) samples by volatilization was developed under laboratory-controlled conditions. The apparatus has a sample and an absorption chamber system. The absorption chamber systems were used a controlled capture system which comprised a 500-mL flask container with a lid with an air inlet (8 hours and 1 bar/minute) and outlet on top side. The soil+peat+urea sample was set as 25 g soil+0.4 g peat+urea fertilizer (100 and 200 kg N/ha) and without peat as control to each application. The pure water enriched with these nitrogenous fertilizers and applied to the soil in the controlled system. The pump outlet was connected to the absorption system, forcing the head-space gases to bubble-up through a 2% boric acid solution, so absorbing the volatilized ammonia was determined with using 0.005 N H_2SO_4.

III. RESULT AND DISCUSSION

A. The losses and of NH_3 (%) with using BToP

The environmental pollution and theirs effecting factors have been studies in recent years. These studies have aimed regulating and reducing this pollution. It follows that ammonia pollution must be managed without excessive contribution to soil, water, or air pollution and be compatible with efficient using nitrogen fertilizers. Comparative ammonia (NH_3) losses were assessed using BToP as a static sorbent in this laboratory study. The loss of NH_3 (%) from urea was given into the Table 5.

TABLE 5. THE LOSSES AND OF NH_3 (%) FROM UREA AND LIMITING WITH USING BTOP.

Soil	Urea treatment, kg N/ha	Limitation of losses of NH_3 with BToP treatment, %		
		5	10	20
1	250	8,3	11,1	11,1
	500	18,8	24,6	26,1
2	250	11,1	19,4	19,4
	500	11,4	29,5	31,8
3	250	0	16,7	16,7
	500	18,1	23,6	25,0
Min.	250	0	11,1	11,1
	500	11,4	23,6	25,5
Max.	250	11,1	19,4	19,4
	500	18,8	29,5	31,8

For having high calcareous soils and clay content, at the 1st and 2nd samples maximum limitations were obtained from BToP treatments. But for having low calcareous soils, at the 3rd sample 50% 0f minimum limitation was obtained from BToP treatments. Bark of trees especially in this BToP mainly may be used as a limitation matter to loss of NH_3 by volatilization.

B. The losses and of NH_3 (%) with using straw and wood shaving

Comparative ammonia losses form nitrogenous fertilizers were determined and limited with using straw and wood shaving as sorbent were added to the soil and fertilizer compound. The losses of NH_3 (ppm) from urea fertilizers were given into the Table 6.

TABLE 6. THE LOSSES OF NH_3 (PPM) FROM UREA FERTILIZER WITH USING STRAW AND WOOD SHAVING.

Fertilizer	N dose, ppm	Losses of NH_3, ppm	N loses, %	Limitation of N losses, %	
				Straw	Wood shaving
Urea	100	3,50	3,50	2,42 (30,86%)	2,80 (20,00%)
	200	3,50	1,75	1,33 (24,00%)	1,54 (12,00%)
	300	3,50	1,17	0,89 (23,93%)	0,99 (15,39%)

For having soil with high clay content, the losses of ammonia from urea fertilizers were limited to 30,86% and 20% as maximum limitations of ammonia losses at 100 ppm with straw and wood shaving application, respectively. The losses from urea fertilizer were limited with using straw and wood shaving, but cause of two types organic material level was used 2 g in the high level of fertilizer applications to limiting of ammonia losses decreased with high level of nitrogen applications.

C. The losses and of NH_3 (ppm) with using of peat

The volatilized ammonia was determined from the controlled system at the concentration of NH_3-N (Table 7). Absorption by peat in this experiment recovered at 11.6% and 20.6% of the volatilized ammonia.

TABLE 5. THE LOSSES OF NH_3 (PPM) FROM UREA WITH USING PEAT.

Fertilizer	Nitrogen doses, kg/ha	The losses of NH_3, ppm	NH_3 losses with peat, ppm	Limitation of N losses, %
Urea	100	3,08	2,97	11.6
	200	3,36	3,00	20.6

IV. CONCLUSION

Separately, in this subject it is necessary to many studies will be to limitation of volatilization. A special injection assembly is to apply it into the soil at a depth of 15 to 20 cm to avoid loss of NH_3 by volatilization. In many cases it is not opportune to apply all the nitrogen in one dressing but rather to split the total amount into two or several application. This type of nitrogen treatment is particularly common in intensive cropping systems where crop yields are high and where large amounts of nutrients are applied.

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