Denitrification Rated Soil Respiration with Respect to Organic Substrate Applications in Çukurova Region

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1. Introduction

At the regions that the two crops taken annually (e.g. Çukurova region), after the wheat, which is a first crop, the plant residues have been fired which deteriorated organic matter. Recently, the use of organic wastes and green manures to keep soil quality and agriculture sustainability by farmers significantly increased in Turkey. This practice recommended integrating lack of mineral fertilization, increasing importance of sustainable agriculture and energy conserving in soils. Laws and regulations are forcing integrated landscape recycling concepts because landfills are lacking and sea dumping is restricted or even forbidden.

The agricultural sector causes about 25%, 65% and 90% of anthropogenic global CO_2, CH_4 and N_2O emissions, respectively, and has a wide influence on NH_3 and NO emissions. Main sources of Green House Gas (GHG) emissions are N_2O emissions from soils, N_2O and CO_2 emissions from cultivated organic soils, CH_4 emissions from enteric fermentation and CH_4 and N_2O emissions from manure management. The reduction of these GHG emissions could be realized by different measures and strategies

Denitrification is an aerobic energy conserving process that may occur alternatively or simultaneously with respiration and nitrification (Benckiser et al., 1995). Most of the N_2O is released from biological processes in soil, mainly from microbial denitrification and nitrification (Davidson, 1991). Nitrous oxide (N_2O) is about 300 times more powerful greenhouse gas than carbon dioxide over a 100-year time horizon (IPCC, 2001). Agricultural soils have been regarded as the main producers of anthropogenic N_2O emissions (Kasimir-Klemedtsson et al., 1997; Kroeze et al., 1999).

Simarmata et al. (1991), worked on field condition with organic straw addition, reported that the highest denitrification losses occurred in plots without organic straw application and just after mineral fertilization.

Mengel and Schmeer (1985), Gök and Ottow 1988 and Simarmata et. al.(1991) pointed that straw application enhanced immobilization and so decreased N leaching and with this way organic residues treatments reduced the groundwater pollution. In the Çukurova region the amounts of NO^-_3-N which has a leaching rise, under wheat or corn vegetation, changes between 40-60 kg ha^{-1}, however, after mineral fertilization and/or intensive mineralization it may became up to 200-230 kg NO^-_3-N ha^{-1}. Thus, for the soils of Turkey it is more important to use of organic residues or green manures.

Since organic material incorporation to soil enhanced C and N content of soil, microbial biomass, soil respiration and dehydrogenase activity as well as mineralization increases (Frazer et al, 1988, Bhardjaw and Datt, 1995).

Nitrous oxide (N_2O) is a long-lived atmospheric trace gas that influences the climate as a greenhouse gas (Dickenson and Cicerone, 1986) and participates in the

Table 1. Carbon and nitrogen contents along with C/N ratio of the organic substrates used

Organic Substrates	Years	C (%)	N (%)	C/N
Wheat straw	1995-1996	49.50	0.70	70.7
	1996-1997	44.06	0.65	67.8
Corn straw	1995-1996	45.18	0.59	76.6
	1996-1997	49.99	0.63	79.3
Soja straw	1995-1996	32.20	0.75	42.9
	1996-1997	-	-	-
Rice hull	1995-1996	-	-	-
	1996-1997	49.21	0.67	73.4
Tobacco res.	1995-1996	42.29	2.16	19.6
	1996-1997	48.59	2.26	21.5
Animal manure	1995-1996	23.56	1.89	12.5
	1996-1997	-	-	-

formation and destruction of stratospheric ozone (Cicerone, 1987). Atmospheric N_2O levels have risen approximately 15% since pre-industrial times (Prather et al., 1994). There are many sources of N_2O but soil is believed to be the predominant source, contributing about 70% of the total N_2O emitted from the biosphere into the atmosphere (Bouwman, 1990).

Carbon dioxide plays a critical role in Earth's climate and radiation balance as a greenhouse gas contributing to global warming. A major source of CO_2 is industrial emissions, with average global atmospheric levels of 367 parts per million (ppm) in 1999, significantly higher than the pre-industrial revolution atmospheric concentration of 280 ppm (IPCC, 2001).

The aims of the research series demonstrated here were to determine the effects of different land use practices on nitrogen turnover, denitrification and soil microbial activity. In this manuscript the values summarized, thus, denitrification and microbial activity parameters such as CO_2 production and dehydrogenase activity values presented.

2. Material

The organic matter, total N content, $CaCO_3$, sand, loam, clay content, soil texture, total salt content, CEC (cation exchange capacity), P_2O_5, K and pH values of the experimental soil were found 1.37%, 0.126%, 35.4%, 17.9%, 39.4%, 42.8%, C (clay), 0.086%, 23.9 me/100g, 79.5 kg ha^{-1}, 840 μg g^{-1} and 7.70 respectively. Carbon and nitrogen contents along with C/N ratio of the organic substrates used were given Table 1.

3. Methods

Nitrogen loss by denitrification at the field conditions was measured with Acetylene-Inhibition-Technique (AIT). Since calcium carbide use is easy, it was used instead of acetylene gas in Acetylene inhibition method. Calcium carbide was converted to acetylene gas in the soil by combination with water ($CaC_2 + H_2O$ □ $C_2H_2 + CaO$). Molecular sieve was used to capture N_2O in the soil; natron kalk and silica gel were used to capture CO_2 and H_2O in the soil, respectively to measure denitrification by AIT procedure. Calcium carbide first placed in the soil and N_2O was captured by molecular sieve in the measuring system. Then N_2O was solved in water to be analyzed in the Gas Chromatography in N_2O-N ha^{-1} a^{-1} (Benckiser et al., 1995). CO_2 production was analyzed according to Isermeyer (1952) and dehydrogenase enzyme activity (DHA) was analyzed according to Thalmann (1967).

4. Results

Directly measured denitrification losses in the field using Acetylene Inhibition Technique (AIT) on the N_2O level reveal N emission rates of a few grams to about 120 g N_2O-N ha^{-1} day^{-1}. CO_2 formation was varying 107 to 363 kg CO_2-C ha^{-1} day^{-1}. The CO_2 formation results confirm the findings obtained by the DHA as a measure of microbial activity.

Results obtained outlined that organic residue or green manure applications decreased denitrification losses from added total nitrogen to soil, however increased mean N_2O fluxes compared to control.

Since, organic matter content of arable lands in Turkey were generally insufficient (1-2%), the use of organic wastes and green

manures to keep soil quality and agriculture sustainability by farmers significantly increased. This practice recommended integrating lack of mineral fertilization, increasing importance of sustainable agriculture. Organic substrates or green manure applications may be a viable means to reduce N_2O emissions while maintain soil quality. The results here suggest that organic substrate and green manure applications reduced N_2O-N surface fluxes in % of total added N. Based on these results land use and management are the important considerations in designing a GHG mitigation strategy for the Turkey.

Estimates of the N_2O flux from agricultural cropland has special importance due to the Kyoto protocol committed the European Union (EU) member states to an 8% reduction in the emission of Green House Gases (GHG) by 2008 to 2012 relative to 1990. Thus, mitigation options and strategies researches for GHG emission from agriculture is important for the Turkey that come step by step closer to its goal of EU membership.

Our studies have shown the usefulness data to approach in comparing different management systems, however, little is known about the effects of alternative soil management practices on N_2O emissions.

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