STUDIES OF METHANE AND NITROUS OXIDE IN WETLAND

RICE PADDY COSYSTEMS OF SOUTH INDIA

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ABSTRACT

The most important contributions to enhanced greenhouse effect are by carbon dioxide (62%), methane (20%), and nitrous oxide (4%). Methane (CH_4) and nitrous oxide (N_20) are currently increasing in the atmosphere at a rate of 7 ppbv yr^{-1} and 0.7 ppbv yr^{-1} respectively. Thus in an effort to reduce uncertainties, this research work was carried at to quantify the source strength of CH_4 and N_20, its possible biospheric sink in wetland rice paddy ecosystem..

Bi-weekly CH_4 flux studies were performed with rice cultivar variety ADT-36 in the field located within the Anna University Campus in Chennai, South India. In the microcosm studies impacts of biological amendments (biofertilizers) on CH_4 emission were studied with control, Azolla, and Azospirillum amendments. The Azolla amendment has enhanced CH_4 fluxes by 35% than the control while the Asospirillum amendment resulted from reduced CH_4 emission by 8.65% than the control. The anaerobic flux measurements were also done from 20^{th} day after transplantation (DAT) of rice seedlings until maturity with an interval of 10 days. The anaerobic CH_4 flux rates were high for the Azolla amended microcosms (73.52 -165.56 mg $m^{-2}d^{-1)}$ in comparison with control. The effect of organic (Acetobacter, Phosphobacter), inorganic (urea, super phosphate) amendment on CH_4 emission was monitored using microcosms. The application of urea has resulted in higher CH_4 emission by 15.5% in comparison with control. The Acetobacter amended microcosm resulted in reduced CH_4 emission by 4.4% in comparison with control microcosms. While the Super phosphate and Phosphobacter application resulted in 11.8% and 20.6% respectively in comparison with control microcosms. Also, the impact of biological amendments namely Pseudomonas and Nemento (neem extract) on CH_4 and N_20 emissions from cores was monitored throughout the entire cropping period. The Nemento, being the nitrification

inhibitor significantly reduced $_{CH4}$ and N_20 emission in comparison with control and Pseudomonas amended cores.

The Diel variation of CH_4 and N_20 fluxes were studied in cores with biological treatments like pseudomonas and Nemento. In the forenoon the CH_4 and N_20 emission increased significantly, and were maximum during early afternoon (14:00-15:00 hours). The emission decreased and remained more or less constant during night. Nemento being a nitrification inhibitor reduces both CH_4 and N_20 effectively in comparison with control and pseudomonas amendment.

The second aspect of the study was done on CH_4 and N_20 analysis in soil pore water. The CH_4 in soil pore water was studied during tillering, flowering and harvesting stages of rice plant. CH_4 concentration was measured in the rice plants amended with Azolla and Azospirillum. In general, CH_4 concentration in soil pore water increased with depth at all the stages of rice plant. The application of Azolla (0.03 to 0.086 µmol $gdwt^{-1}$) resulted in increase in CH_4 concentration along the profile. The high CH_4 concentration on treatment with Azolla was mainly due to increased input of organic matter to the sediments. The **CH_4** in soil pore water was also studied in rice plants amended with organic (Acetobacter, Phosphobacter) and inorganic amendments (urea, super phosphate). The urea amendment has resulted in increase in CH_4 concentration in comparison with control while Acetobacter application has resulted in a decrease in CH_4 concentration in comparison with urea amendment along the soil profile. Also, the application of Phosphobacter resulted in reduced CH_4 concentration in comparison with super phosphate amended microcosms. Finally, CH_4 and N_20 analysis in soil pore water was conducted in cores amended with Pseudomonas and Nemento (nitrification inhibitor). The application of Nemento resulted in low CH_4 and N_20 concentrations along the profile in comparison with control cores.

The *in vitro* CH_4 production studies in soil profiles were carried out at different stages of rice plants to study the effect of biofertilizers like Azolla and Azospirillum. The CH_4 production rate is always lower in the upper soil layer in comparison with the lower

zone. The CH_4 production rate is always higher in Azolla (0.0043 µmol $gdwt^{-1}$ h^{-1}) in comparison with control. Additionally, the impact of organic (Acetobacter, Phosphobacter) and inorganic fertilizers (urea, super phosphate) on *in vitro* CH_4 production in soil profiles were monitored. The concentration of electron acceptors ($S0_4^{2-}$, Fe^{3+}, $N0_3^-$) was also analyzed before and after incubation.

The CH_4 production potentials of different agricultural soils (alfisol and Inceptisol soil type) from cultivated and harvested fields on long-term incubations were observed so that to simulate reduction processes that occur upon flooding of rice soil. The concentration of electron acceptors ($S0_4^{2-}$, $Fe^{3+,}$ $N0_3$") was analyzed together with CH_4 analysis. The maximum CH_4 production rate was observed in Hapluslalfs (2.70 µmol $gdwt^{-1}$) soils.

The third aspect of study involves *in vitro* production and oxidation of CH_4 in rice roots during different growing stages of the plant. The *in vitro* production of CH_4 was studied in rice microcosm amended with Azolla and Azospirillum. The application of Azolla has resulted in enhanced methane production throughout the growing period in comparison to Control and Azospirillum amended rice microcosms. The *in vitro* production of CH_4 was also compared between rice microcosm treated with organic (Acetobacter, Phosphobacter) and inorganic (urea, super phosphate) amendment. The application of acetobacter and Phosphobacter has resulted in less CH_4 production in comparison with urea and super phosphate amendment. The *in vitro* oxidation of CH_4 in roots was monitored during different growing stages of rice plants amended with Azolla and Azospirillum. The maximum CKU oxidation was observed during the initial 25-35 hours of incubation. In Azolla amendment the oxidation rate was higher in comparison with control. The use of Azolla over the soil surface may slightly enhance the net amount of CH_4 available for transport into the overlying water. The CH_4 may be oxidized by the finer Azolla root, which is suspected to harbour methanotrophic bacterial population.

In conclusion, rice paddy ecosystem is considered to be one of the anthropogenic sources of atmospheric CH_4 and N_20. From the studies, it is clear that significant fraction of CH_4 and N_20 evolved can be avoided by the proper usage of nitrification inhibitor like

nemento, biological amendment like pseudomonas, and acetobacter. The novel mitigation measures attempted using microorganisms serve as alternative to conventional and chemical measures.