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RESEARCH ARTICLE

A SHORT TERM STUDY OF METHANE EMISSION FROM WHEAT AGRICULTURE FIELD.

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Abstract

The global Green House Gas (GHG) Methane emission has increased 15% from 1990 to 2010, where agriculture sector contributes more than 65% to Indian Methane emission. Methane is considered as the major GHG because of its residence time in the atmosphere as well as due to its Global Warming Potential. In present study Methane emission from Wheat agriculture field was assessed for a period of one month using closed static chamber method. Sampling was carried out on weekly basis to see temporal variation taking place in a very short period of time. A correlation between physico chemical parameters and the emitted CH_4 flux was also carried out. Methane flux ranged from 0.006 $mg/m^2/hr$ to 0.56$mg/m^2/hr$. The controlling edaphic factors for CH_4 emission are also discussed.

Introduction:-

Green House Gases(GHG) are those gaseous constituents of the atmosphere, both natural and anthropogenic that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the earth's surface, the atmosphere and clouds.Water vapour (H_2O), Carbon dioxide (CO_2), Nitrous oxide (N_2O), Methane (CH_4), and Ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. Moreover, manmade gases are also considered as GHG such as the halocarbons and other chlorine and bromine containing substances (IPCC, 2001).

Out of the all GHGs CO_2, CH_4 and N_2O draw a special attention because of their high residence time and Global Warming Potential. Green House Gas Methane has a G.W.P of 23 and a life time of 12±3 years (UNFCCC, 2014). As sources of CH_4 are abundant, making it a potent G.H.G. Methane is emitted from both, natural as well as anthropogenic sources. Major natural sources of methane are wetlands, termites and oceans and main anthropogenic sources are landfill sites, livestock farming as well as production and transportation of the fossil fuels (Nara et al., 2014).

Mallick and Dutta, (2009) monitored CH_4 emission from sub-tropical wetlands dominated with *Scirpus littoralis* and found that Wetlands act as a both emitter and sink of Methane. Moscher et al., (1999) worked to measure Methane emission from landfill site at north eastern U.S.

India is mainly dependent on agriculture sector for economy and food production. Land use and land change pattern, soil type, availability of soil minerals and the climatic condition play a major role in Methane emission (Bhatia et al., 2004).Mathew et al.,(2010)assessed CH_4 emission from rice agriculture field in Mannuthy and correlated Methane emission and growth stages. Kessavalou et al.(1998) worked on CO_2, N_2O and CH_4 from Grass Sod and Winter Wheat-Fallow Tillage Management. However, little work is reported on CH_4 emission from wheat cultivation and hence the present work is carried out. The present work deals with examination of methane flux from wheat cultivationwith an objective of monitoring temporal variation of CH_4 emission as well as to correlate physico-chemical parameters of the soil condition with CH_4 flux.

Materials& Methods:-

The study area Wheat agriculture field at Khodiyar village, Anand Gujarat was selected to monitor temporal variation of Methane flux in relation to soil chemistry.

Description of Site:-

The study area Khodiyar village is situated between 22º 34’ 27.55 85” N latitude and 72 º 56’ 27.9812” E longitude which is 5 km away from Vallabh Vidyanagar. The total area of the agricultural field is 9728.06 sq. m. The average temperature of the area remains around 29°C. The average pressure prevailing in the area is 1005.16 h pa. The area receives annual rainfall during the months of July to September. The soil type is granular and coarse. Most of the times the soil remains dry, forming hard lumps. Soil appears light brown in colour having good amount of organic carbon. The topography of the area is flat. Conventional type of farming practice is followed in this area with the use of chemical fertilizers and pesticides.

Methane emission sampling:-

Closed static chamber method was used to measure CH_4 emission (Colier et al., 2014). The closed chamber was designed using nonreactive transparent plastic material having dimension of 44cm×33cm×22cm.within the chamber a small fan was installed on the top surface for equal distribution of the air in chamber. A small area of 1cm diameter was fixed with rubber cork for easy sample collection. A Thermometer was also fitted in chamber for measuring temperature.

Gas sampling was carried out for a period of 21days starting from 2^{nd} week of January to first week of February on weekly basis. The gas samples were collected at every half an hour interval from 3pm to 5 pm. During gas sampling, the instrument was fixed on site taking precaution to insert the lower edge of the chamber 5cm deep into the soil to avoid any gas leakage. Gas samples were collected in 10 ml glass vials using a 20ml disposable syringe. The samples were drawn into syringe using a three way stop cork and then injected in pre evacuated glass vials. After the collection, samples were preserved in icebox and brought to the laboratory. They were further stored in refrigerator until taken for gas chromatography analysis. Methane gas concentration was analysed at Sophisticated Instrumentation Centre for Applied Research and Testing (SICART) Vallabh Vidyanagar, Gujarat, India using Perkin Elmer Auto system gas chromatograph equipped with Flame Ionisation Detector (F.I.D).The area obtained in gas chromatography was converted into concentration (ppm) using standard methane concentration

The value obtained for gas concentration was used to calculate methane flux using following formula.

$$F=\rho \frac{V}{A}\frac{P}{P0}\frac{T0}{T}\frac{dCt}{dt}$$

Source: (Nirmal kumar et al., 2012)

Where,

F is CH_4, CO_2, and N_2O gas flux (mg /m^2/hr)

ꝑ is gas density at the test temperature (mg/m^3)

V is chamber volume available (m^3)

A is bottom area of the chamber (m^2)

P is atmospheric pressure in the field (h Pa)

P_0 is atmospheric pressure under standard condition (h Pa)

T_0 is absolute air temperature under standard conditions (25ºC)

T is absolute air temperature in chamber at the time of sampling (ºC)

C is concentration of mixed volume ratio of gases in chamber at time t (10^{-6}).

Soil sample collection:-

Soil samples were collected simultaneously at half an hour interval from the sampling site with the help of spade and were packed in polythene zipped bag and brought to the laboratory. The samples were air dried and further used for assessment of soil parameters such as T.O.C, pH. Soil temperature was recorded onsite.

Result & Discussion:-

Methane emission monitoring was carried out for 21 days by closed static chamber method. Throughout the study period the minimum methane emission observed was 0.006 $mg/m^2/hr$ and the maximum methane emission observed was 0.56 $mg/m^2/hr$ (fig 1).The mean values obtained were the minimum of 0.06 $mg/m^2/day$ and the maximum of 0.24 $mg/m^2/day$. The methane emission was found increasing for one week period which gradually decreased during rest of the time period. In the study period higher CH_4 emission was observed at the initial period i.e., 7th day and at later stage it showed a decrease in emission flux. These results are very well matched with Schutz et al., (1989)

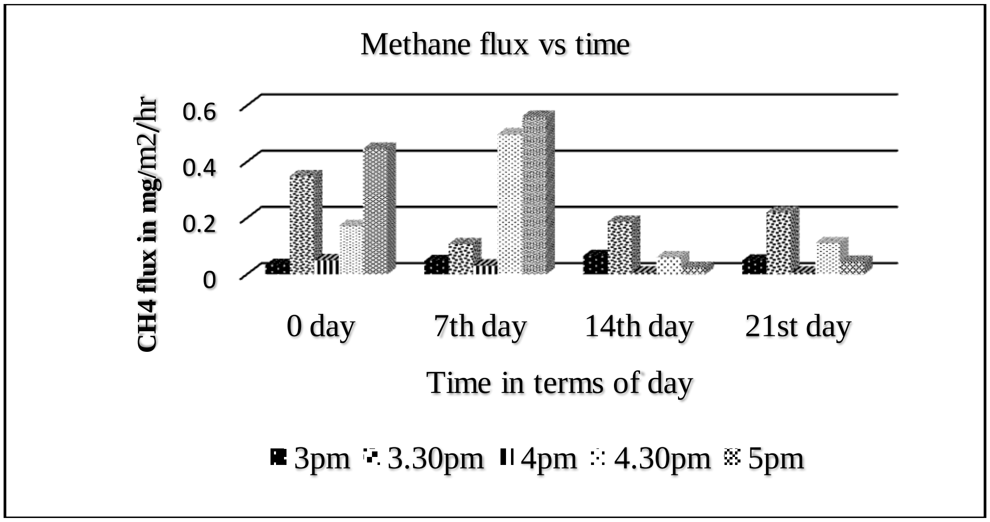

Fig 1:-Temporal variation in Methane (CH_4) flux at Wheat farm for 21 days of sampling during the time 3pm to 5 pm.

The weekly sampling days are mentioned as 0 day, 7 day, 14 day and 21day. In each day value the CH_4 variation with time 3pm, 3.30 pm, 4 pm, 4.30 pm, 5pm is shown

Temporal variation in a single day was studied by comparing Methane flux with time. i.e., Methane flux in $mg/m^2/hr$ .Methane gas followed the same pattern of emission for the first two weeks that is 0 day and 7th day reading and a peak was obtained for the time period of 4.30 pm to 5.00 pm while for 14th day and 21st day of sampling the gas emission followed another pattern in which maximum emission took place at 3.30 pm and at 4.00 pm minimum CH_4 emission was observed. However during 21 day of sampling maximum emission was observed at 7th day of sampling at incubation period of 4.30 pm to 5pm.

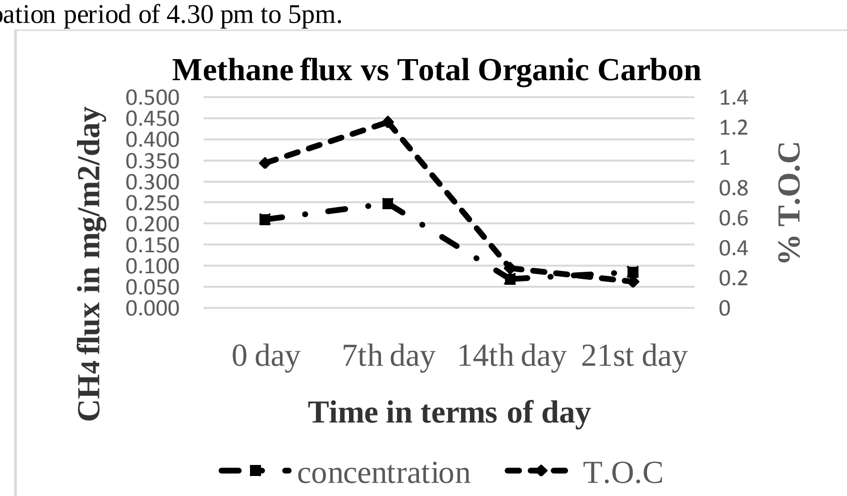

Fig 2:- Average per day CH_4 flux variation against average per day Total Organic Carbon value.

The series concentration shows average daily CH_4 flux obtained by averaging the value obtained between 3pm to 5 pm in a single day of sampling. The series T.O.C shows average Total Organic Carbon value obtained from averaging out the values obtained for T.O.C in a single day during 3pm to 5 pm. The figure shows comparison between average value of CH_4 flux in mg/m^2/day and average T.O.C value/day

Throughout the sampling period Total Organic Carbon (T.O.C) ranged from 0.15% to 0.96 % CH_4 emission value was found to increase with increase in Total Organic Carbon (T.O.C). Less T.O.C gave less methane emission which showed that the organic matter was not converted in to simpler form by the microbes. (fig 2) Correlation analysis between T.O.C and CH_4 was 0.99. This result matches with the work of (Lu et al., 2000; Verma et al., 2002)

pH of the soil was almost neutral throughout the sampling period (6.9 to 7.3).It was observed that maximum CH_4 emission was observed on 7th day at the pH value 7.2 (fig 3)The data showed that CH_4 emission was parallel with the pH value which was confirmed by correlation analysis r = 0.32. Wang et al., (1993) confirmed that with a small increase in pH results in enhancement of CH_4 by 11% to 40%.

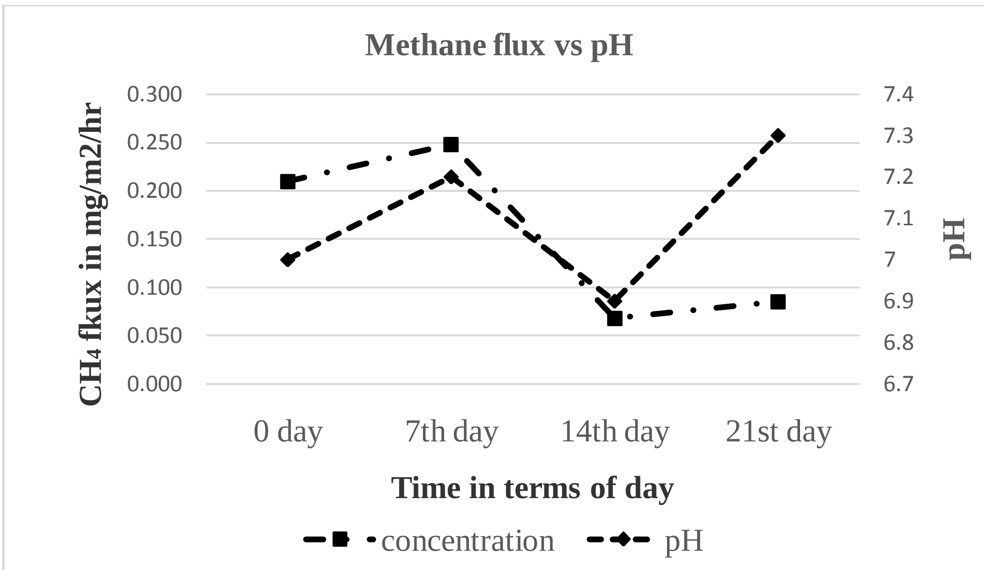

Fig 3:- Average per day CH_4 flux variation against average per day pH value.

The series concentration shows average daily CH_4 flux obtained by averaging the value obtained between 3pm to 5 pm in a single day of sampling. The series pH shows average pH value obtained from averaging out the values obtained for pH in a single day during 3pm to pm. The figure shows comparison between average value of CH_4 flux in mg/m^2/day and average pH value/day

Temperature of the soil varied from 20ºc to 24ºc. (fig 4)The value of temperature was found to be positively correlated with CH_4 flux value (r = 0.86).M.A.Khalil et al., (1998) also confirmed that CH_4 emission increased with increase in soil temperature.

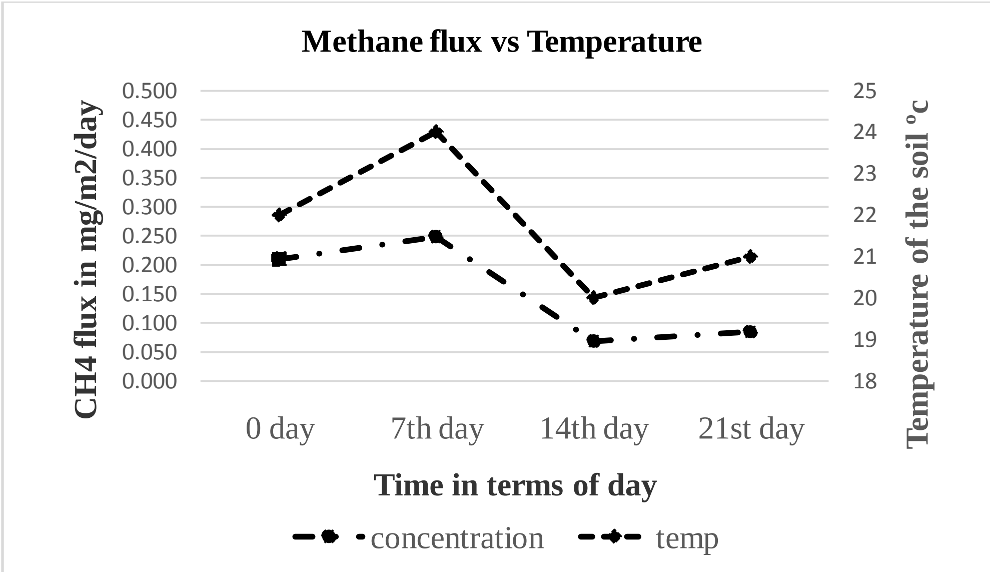

Fig 4:- Average per day CH_4 flux variation against average per day Temperature value.

The series concentration shows average daily CH_4 flux obtained by averaging the value obtained between 3pm to 5 pm in a single day of sampling. The series temp shows average temperature value obtained from averaging out the values obtained for temperature in a single day during 3pm to pm. The figure shows comparison between average value of CH_4 flux in mg/m^2/day and average temperature value/day.

Conclusion:-

1. The present study concludes that the use of Close Static Chamber method is effective to collect the G.H.Gs
2. The study reveals that CH_4 emission follows temporal variation.
3. CH_4 emission depends on several physico chemical parameters of the soil as well as the climatic condition which triggers or affects the microbial activity responsible for CH_4 emission

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