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# METHANE EMISSION IN PADDY SOIL ECOSYSTEM UNDER DIFFERENT IRRIGATION REGIMES

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## ABSTRACT

The experiment on the effect of irrigation on methane emission in paddy soil ecosystem during kharif and rabi season of 1995-1996 revealed that mid season aeration recorded minimum methane flux value (0.69 mg $m^{-2}$ $h^{-1}$). Similarly, intermittent irrigation reduced $CH_4$ flux (9.2 mg $m^{-2}$ $h^{-1}$) than the normal irrigation (25.3 mg $m^{-2}$ $h^{-1}$) in both kharif and rabi season.

KEY WORDS: Paddy ecosystem, Irrigation regimes, Methane emission

Methane is one of the major "Green house" gases. The methane concentration in the troposphere is currently about 1.75 ppmv and is increasing at a rate of about 0.016 ppmv per year (Blake and Rowland, 1988). Methane production in submerged soil results in the formation of gas bubbles which remain in the soil until their buoyancy is sufficient for ebullition in vegetative soil. Paddy fields predominantly existing in tropical developing countries contribute about 25 per cent of the total global emission of methane through anaerobic fermentation of organic substrates by methanogenic bacteria in the soil (Renenberg *et al.*, 1992). In order to reduce the evolution of methane from flooded rice, field management practices must be developed without the decreasing rice quality and yield. With this in view, the present study was aimed to study influence of irrigation management in reducing the $CH_4$ emission from paddy fields.

## MATERIALS AND METHODS

A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore, during kharif and rabi seasons of the year 1995-1996, in Randomised Block Design with three replications. An experimental plot was maintained with varying levels of irrigation. Normal irrigation - $I_1$ (5 cm flooding), Intermittent irrigation - $I_2$ (Irrigation after 3rd day of disappearance of water). Mid season aeration - $I_3$ (7 days drying at any one critical stages of crop growth).

### Analysis

Organic carbon was estimated by chromic acid digestion method of Walkley and Black (1934). The total volatile fatty acids were estimated by following the method of Vancura (1964).

### Methane measurement

Air tight perspecx chamber (approximately 100% volume) with surface area of about 1700 $cm^2$ was placed over the iron frame, placed in the soil at a depth of 6 cm before 24 hours of sampling. This was done to maintain the soil saturation and avoid disturbances to water, soil and air interfaces. Nearly 8-10 hills were accommodated inside the chamber. Gas sampling was done using air tight syringe at every 10 minutes interval for each treatment for 30 minutes.

One ml of gas sample was then directly injected into the Perkin-Elmer gas chromatography equipped with a Porapak-Q-column and flame ionisation detector (oven temperature 70° C. Injector and Detector temperature 90° C). Nitrogen gas was used as a carrier gas (30 ml/min). Oxygen and hydrogen gases were used for the flame. Methane concentration was calculated from the chromatogram and $CH_4$ flux was calculated by following the formula of Shyamlal *et al.* (1993).

$$\frac{M.\ n(air)\ V \times dr}{N.\ a \times dt} \times 10^7$$

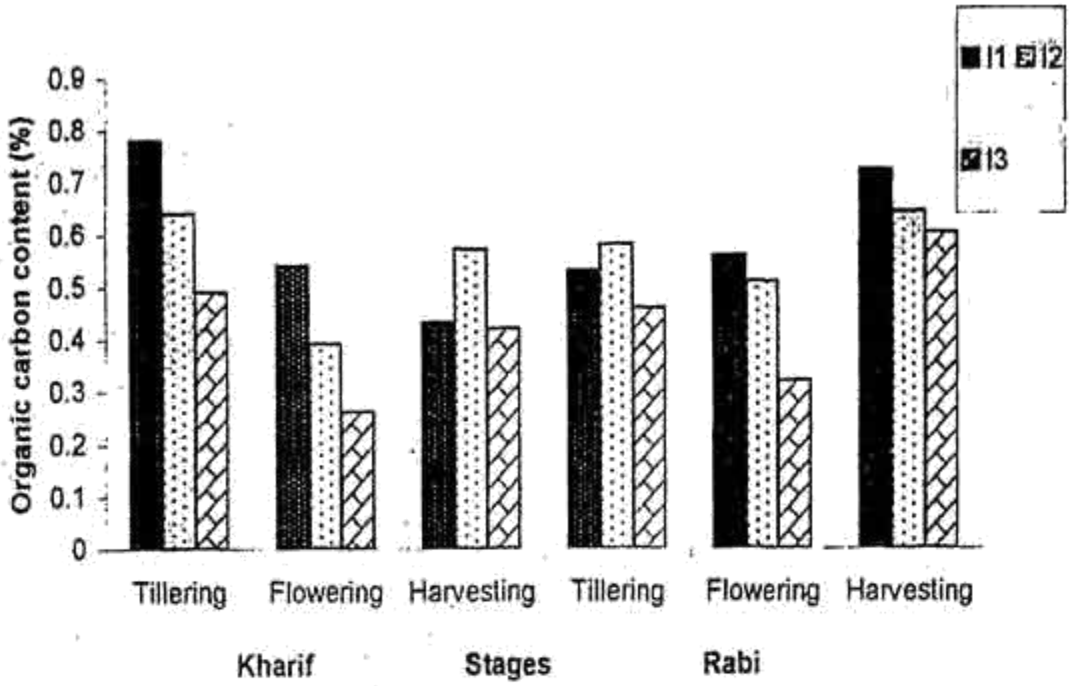

**Fig 1. Organic carbon content of the soil (%) at different stages of crop growth during karif and Rabi, 1995-1996**

M - Molecular weight of $CH_4$ (g)
N - Avogadro's number (Molecules / g mole)
n (air) - Air density
V - Chamber volume ($cm^3$)
A - Surface area of the chamber
dr / dt - Rate of change of $CH_4$ mixing ratio (h)
r - Methane concentration in ppmv
t - Time

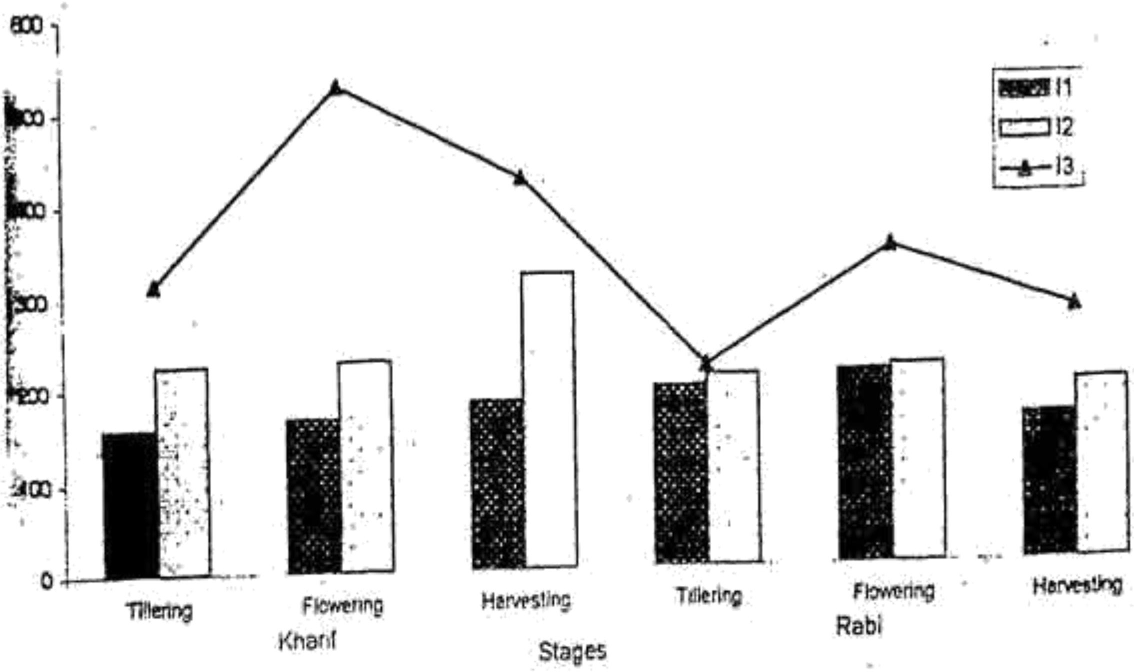

**Fig 2. Volatile fatty acids of the soil (mg/l) at different stages of crop growth during kharif and rabi seasons of 1995-96**

## RESULTS AND DISCUSSION

### Organic carbon

Organic carbon in Normal irrigation ($I_1$) recorded maximum (0.43 - 0.78%) followed by Intermittent irrigation ($I_2$) and mid season aeration ($I_3$) of 0.39 - 0.64% and 0.26 - 0.47% respectively (Fig. 1). Organic carbon content was least in flowering stage (0.26 - 0.54%) than tillering (0.49 - 0.78%) and harvesting stage (0.43 - 0.57%).

### Total volatile fatty acids

Volatile fatty acids production was maximum in mid season aeration $I_3$ 526 mg/l followed by intermittent irrigation ($I_2$ (319.1 mg/l) and normal irrigation ($I_1$) (156.1 mg/l). Among the different stages of crop growth, total volatile fatty acids was maximum in flowering stage (166.4 - 526.0 mg/l) than other stages of crop growth (Fig.2).

### Methane measurement

The effect of irrigation regimes on methane emission in paddy soil ecosystem at kharif and rabi season is given in Fig. 3. During kharif season, at tillering, flowering and harvesting stages, normal irrigation ($I_1$) treatment recorded a $CH_4$ flux value of 25.3,. 9.10 and 7.0 mg m$^{-2}$ h$^{-1}$ respectively and lower $CH_4$ flux was observed at harvesting stages of crop growth. Similarly intermittent irrigation ($I_2$) recorded a $CH_4$ flux value of 9.2, 6.14 and 4.5 mg m$^{-2}$ n$^{-2}$ and midseason aeration treatment ($I_3$) recorded a $CH_4$ flux value of 6.5, 2.2 and 0.69 mg m$^{-2}$ h$^{-1}$ at tillering, flowering and harvesting stages. Among the three irrigation treatments, midseason aeration ($I_3$), recorded minimum flux value (0.69 mg m$^{-2}$ h$^{-1}$) at all stages of crop growth. Seven days drying at flowering stage recorded less flux, the delay in methanogenesis may be explained by aerobic decomposition of root residues during the dry period resulting in a smaller amount of easily decomposable organic matter after flooding (Trolldenier, 1995). High fatty acids and low methane emission was observed in flowering stage which may be due to the non utilization of fatty acids by methanogens and immobilization of N (Kirchmann and Lundvall, 1993). Sass *et al.*, (1992) observed that multiple aeration decreased the

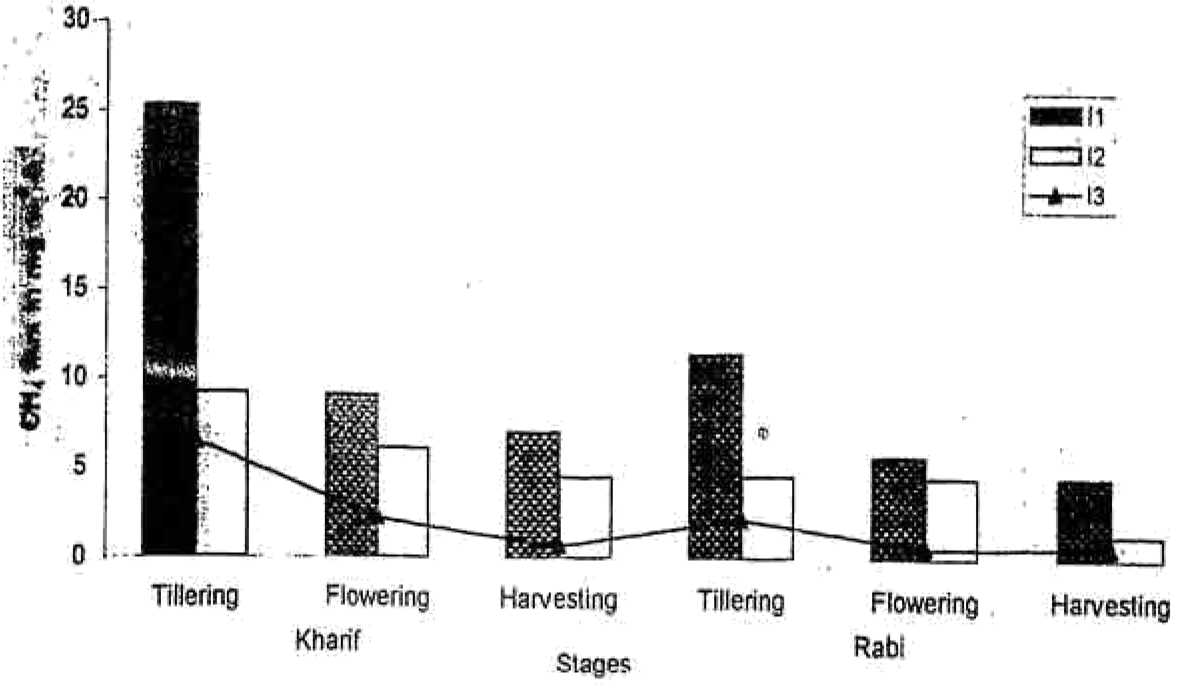

Fig 3. Effect of different irrigation regimes on $CH_4$ flux (mg m$^{-2}$ h$^{-1}$) at kharif and rabi season (1995-96) in paddy soil ecosystem

Table 1. Soil and Air temperature during Kharif and Rabi seasons of 1995-96

| Treatments | Kharif | | | | | | Rabi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tillering | | Flowering | | Harvesting | | Tillering | | Flowering | | Harvesting | |
| | S.T. °C | A.T. °C | S.T. °C | A.T. °C | S.T. °C | A.T. °C | S.T. °C | A.T. °C | S.T. °C | A.T. °C | S.T. °C | A.T. °C |
| $I_1$ | 25 | 38 | 28 | 29 | 24 | 30 | 21 | 31 | 24 | 30 | 25 | 32 |
| $I_2$ | 28 | 32 | 27 | 31 | 27 | 32 | 23 | 28 | 25 | 32 | 24 | 31 |
| $I_3$ | 23 | 33 | 26 | 36 | 25 | 33 | 22 | 29 | 23 | 33 | 23 | 30 |

CD - 1.40

Note :

$I_1$ - Normal irrigation

$I_2$ - Intermittent irrigation

$I_3$ - Midseason aeration

S.T. - Soil temperature

A.T. - Air temperature

seasonal total emission to a lower level, and it has also been supported by Yagi *et al.*, (1994). Similar trend was observed in rabi season also, but its values differed (Fig. 3) During rabi season, different stages of crop growth (tillering, flowering and harvesting) at normal irrigation ($I_1$ )recorded a flux value of 11.37, 5.7 and 4.55 mg m$^{-2}$ h$^{-1}$, intermittent irrigation ($I_2$) recorded 4.6, 4.5 and 1.36 mg m$^{-2}$ h$^{-}$ and mid season aeration ($I_3$ recorded 2.2, 0.66 and 0.68 mg m$^{-2}$ h$^{-1}$). This variation in $CH_4$ emission at kharif and rabi season can be attributed to variation in temperature of the soil and air (Table 1).

Results of the study showed that the rates of methane emission varied markedly with water regimes and that mid season aeration reduced the methane emission by almost 60-75%, but with reduction in grain yield. This implies that further studies on proper strategy of water management are to be carried out to reduce emission of methane from rice field ecosystem as well as to maintain its productivity.

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