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CARBON DIOXIDE EVOLUTION FROM SOIL IN MUNICIPAL SOLID WASTE DUMPING SITES OF BALASORE DISTRICT, INDIA

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ABSTRACT

The emission of carbon dioxide due to anthropogenic activity from the municipal solid waste dumping sites has gained worldwide attention. This work reflects the metabolic activities of the soil of municipal solid waste (MSW) dumping sites in terms of CO_2 evolution, taking the temperature and moisture content of the soil as supporting parameters. In the Balasore district of Odisha state of India there are three notified area councils (NACs) and one municipality that dump their collected solid wastes on the open fields. They are Balasore Sadar (municipality), Soro NAC, Nilagiri NAC and Jaleswar NAC. The present finding says that in all the MSW dumping sites CO_2 evolution was at the higher side than their respective controls, with soil moisture content between 2.74±2.2% to 36.95±1.67% and temperature 21°C to 35°C.

KEY WORDS : CO_2, MSW, Balasore, Soro, Nilagiri, Jaleswar

INTRODUCTION

Carbon sequestration is the modern technique in the present day environmental protection actions which has dragged the attention of the scientists throughout the globe. On one hand the scientists are busy in developing technologies for sequestration of the atmospheric carbon dioxide, on the other hand there is continuous emission of carbon dioxide to the atmosphere by different anthropogenic activities. There are huge areas of lands across the globe where municipal solid wastes are dumped by the concerned authorities. They not only emit foul odour but also emit carbon dioxide to the atmosphere round the clock.

With the creation of new products, industries and society create various types of wastes which affect our natural environment and hamper our daily life. The unusable part of a product which cannot be further used is dumped in the local environment. The waste not only affects the living creatures but also destroys the soil, water and air adding to environmental pollution. The most affected part of the environment due to the dumping of waste is soil. Zhang *et al.*, (2013) experimented on the emission of gaseous fluxes (CH_4, CO_2 and N_2O) in MSW landfilling sites. A report published by Intergovernmental Panel on Climate Change in 2001 stated that the major source of CH_4 emission due to anthropogenic activity was MSW. Assessment of CO_2 evolution is an important indicator for monitoring environmental pollution. This is because of the relationship between plant roots and soil microbes where both contribute to the generation of CO_2 in soil (Mishra and Pradhan, 1987) under stress. Most of the researchers used CO_2 evolution of soil as an indicator for soil health (Ebregt and Boldewijn, 1977; Mishra and Pradhan, 1987; Nakasaki *et al.*, 1992; Serra-Wittling *et al.*, 1995; Joergensen *et al.*, 1996; Busby *et al.*, 2007; Einola *et al.*, 2007). The present experiment intended to evaluate the effect of municipal solid waste dumping in soil CO_2 evolution in the Balasore district.

MATERIALS AND METHODS

CO_2 emission was measured by using the alkali absorption method (Mishra and Dash, 1982). For the collection of the sample, four different sites were chosen. Those are Balasore Sadar, Soro NAC, Nilagiri NAC and Jaleswar NAC. In each site, CO_2 evolution (gCO_2 released permeter square per hour), temperature (^0C) moisture content (gram %)was measured for one year. Each MSW dumping site had its respective control site 1 km away where no contamination of MSW was found. The experimental work was done in the field of both the sites. The experiment started from February, 2017 and ends in January, 2018.

RESULTS AND DISCUSSION

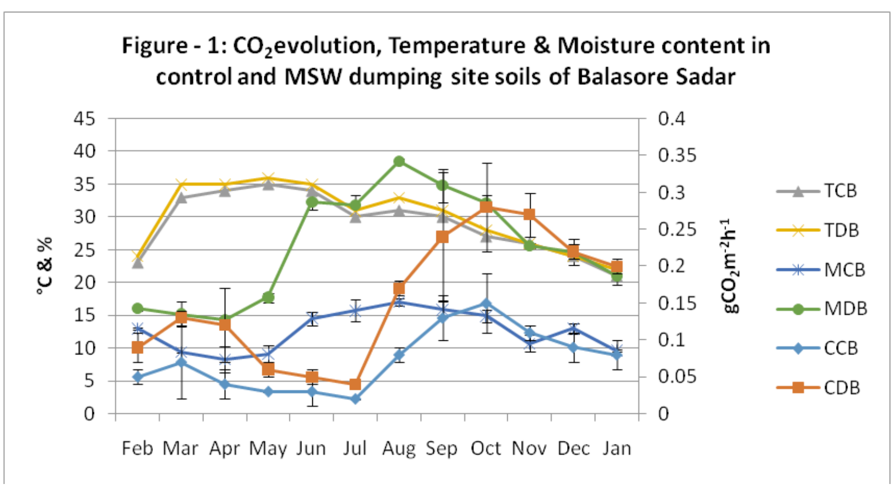
Maximum moisture content was found mostly in between August to October i.e., rainy season, and lowest from April to June i.e., in the summer season.

The figure 1 shows the CO_2evolution from soil in control and dumping site of Balasore Sadar. In the control site the CO_2 was in between 0.02±0.001 $gCO_2m^{-2}hr^{-1}$ to 0.15±0.03 $gCO_2m^{-2}hr^{-1}$. In the MSW dumping site the CO_2 ranged from 0.04±0.002 $gCO_2m^{-2}hr^{-1}$ to 0.28±0.06 $gCO_2m^{-2}hr^{-1}$. The present finding shows that, in the post monsoon period the soil CO_2 evolution was increased. In the present finding, it was found that in each month the soil CO_2 evolution of dumping site was higher as compared their control site. This is because of water availability in soil which increased the soil metabolism. The CO_2 evolution in MSW dumping site soil was significantly ($p\geq0.05$; t = 8.0) increased in post monsoon period as compared to control site soil. This might be due to the increase in moisture content of soil as compared to the pre monsoon months.

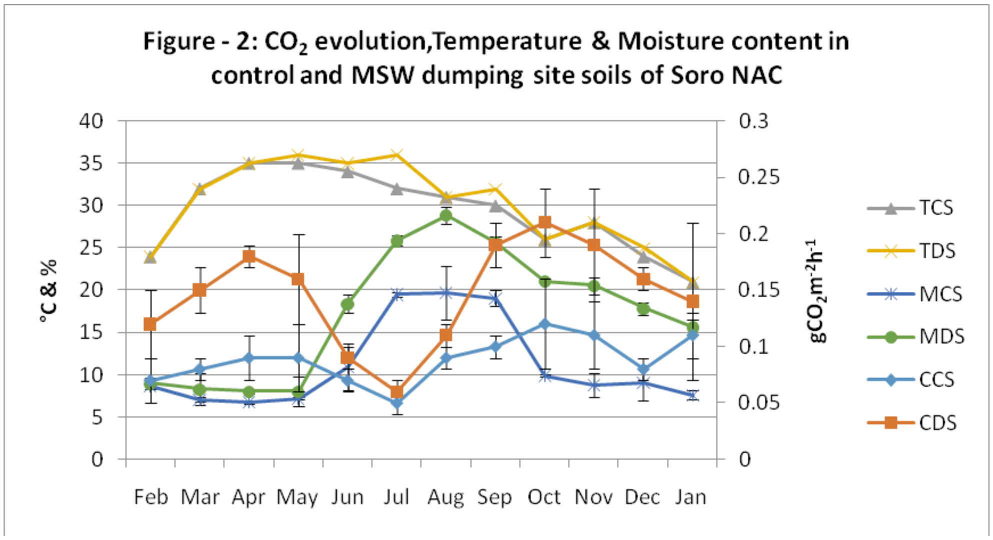
Figure 2 shows the CO_2evolution from soil in control and dumping site of Soro NAC. In the control site the CO_2 evolution ranged from 0.05±0.01 $gCO_2m^{-2}hr^{-1}$ to 0.15±0.04$gCO_2m^{-2}hr^{-1}$ and in MSW dumping site it was ranged from 0.06±0.01 $gCO_2m^{-2}hr^{-1}$ to 0.21±0.03 $gCO_2m^{-2}hr^{-1}$. The declination of CO_2 evolution was initiated after April and later increased in August and so on. In the post monsoon period significant increase ($p\geq0.05$; t = 9.827) in CO_2evolution was observed in MSW dumping site soil as compared to control site soil.

In the figure 3 the CO_2 evolution from soil in control and MSW dumping site of Nilagiri NAC has been shown. The CO_2 evolution ranged between 0.04±0.01 $gCO_2m^{-2}hr^{-1}$ to 0.26±0.03 $gCO_2m^{-2}hr^{-1}$ in control site soil and 0.08±0.003 $gCO_2m^{-2}hr^{-1}$ to 0.27±0.049 $gCO_2m^{-2}hr^{-1}$ in MSW dumping site soil. The soil basal respiration was higher in MSW dumping sites as compared to control site throughout the year but in post monsoon period significant increase ($p\geq0.05$; t = 3.406) was found in MSW dumping site soil. There are two possible reasons behind the inclined effect of CO_2 evolution i.e., increases in soil organic matter and moisture content.

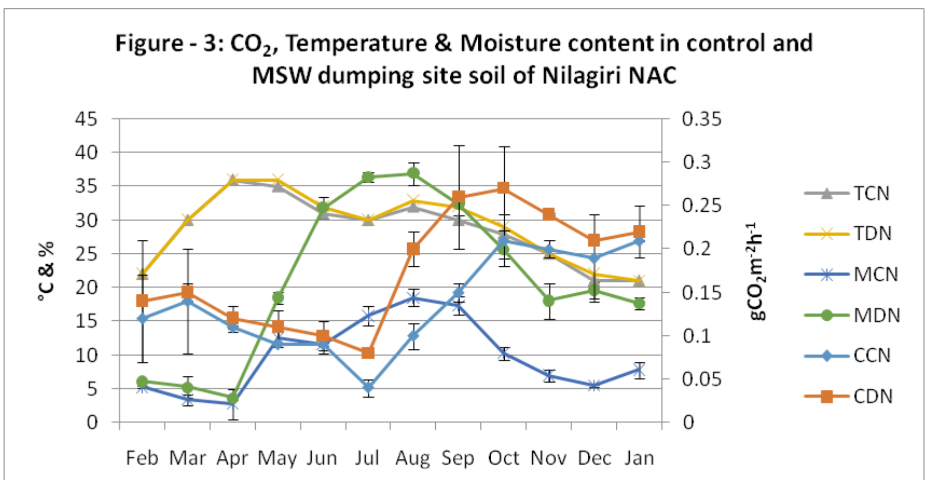
Figure 4 shows the CO_2evolution from soil in control and dumping site of Jaleswar NAC. The control soil CO_2 evolution was in between 0.02±0.001g $CO_2m^{-2}hr^{-1}$ to 0.17±0.06$gCO_2m^{-2}hr^{-1}$ and in MSW dumping site it was0.04±0.03$gCO_2m^{-2}hr^{-1}$ to 0.26±0.02g $CO_2m^{-2}hr^{-1}$. In the dumping site soil the



TCB : Temperature of Control Site soil of Balasore Sadar; TDB : Temperature of MSW Dumping site soil of Balasore Sadar; MCB : Moisture content of Control site soil of Balasore Sadar; MDB : Moisture content of MSW Dumping site soil of BalasoreSadar; CCB : CO_2 evolution of Control site soil of Balasore Sadar; CDB : CO_2 evolution of MSW Dumping site soil of Balasore Sadar



TCS : Temperature of Control Site soil of Soro NAC; TDS : Temperature of MSW Dumping site soil of Soro NAC; MCS : Moisture content of Control site soil of Soro NAC; MDS : Moisture content of MSW Dumping site soil of Soro NAC; CCS : CO_2 evolution of Control site soil of Soro NAC; CDS : CO_2 evolution of MSW Dumping site soil of Soro NAC

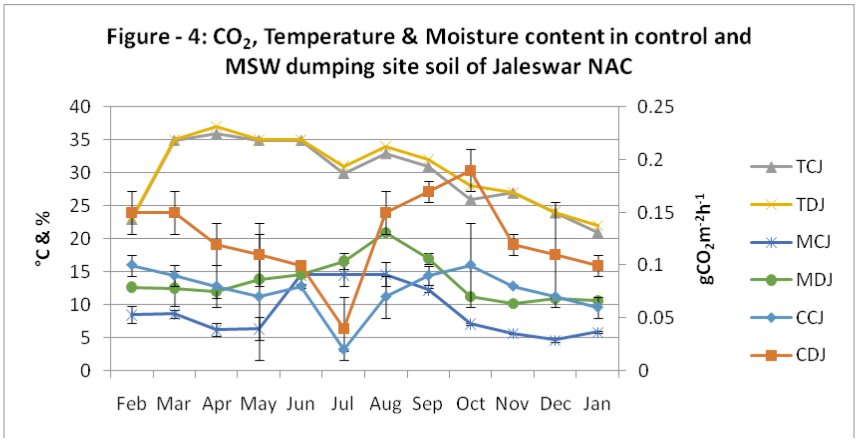


TCN : Temperature of Control Site soil of Nilagiri NAC; TDN : Temperature of MSW Dumping site soil of Nilagiri NAC; MCN : Moisture content of Control site soil of Nilagiri NAC; MDN : Moisture content of MSW Dumping site soil of Nilagiri NAC; CCN : CO_2 evolution of Control site soil of Nilagiri NAC; CDN : CO_2 evolution of MSW Dumping site soil of Nilagiri NAC

soil basal respiration was higher as compared to the control site in each month. Mostly in the post-monsoon part of season, the basal respiration of MSW dumping site soil was significantly increases ($p \geq 0.05$; t = 3.24). This might be due to increase level of moisture or water content in soil with organic fraction.

Saviozzi *et al.,* (2002) had investigated the effect of sewage sludge and farmyard manure on profligate soil. In their findings, it was shown that after the incorporation of sewage sludge, the soil basal respiration increased than farmyard manure. Similarly in our findings, the CO_2 evolution showed increased activity in dumping site soil as compared to the control soil.

Brown and Cotton (2011) had quantified the benefit of compost on agricultural soil in California. After the application of compost in the soil, they found that the soil showed an inclined effect of soil respiration. In our findings, it was found that the municipal dumping site soil showed a higher amount of CO_2evolution than control soil. The possible reason behind this type of result is due to the active amount of organic waste dumping which



TCJ : Temperature of Control Site soil of Jaleswar NAC; TDJ : Temperature of MSW Dumping site soil of Jaleswar NAC; MCJ : Moisture content of Control site soil of Jaleswar NAC; MDJ : Moisture content of MSW Dumping site soil of Jaleswar NAC; CCJ : CO_2 evolution of Control site soil of Jaleswar NAC; CDJ: CO_2 evolution of MSW Dumping site soil of Jaleswar NAC

later on degraded by the microbial activity and releases more amount of CO_2.

Pascual *et al.*, (1997) had experimented on the changes that occur in arid soil due to the introduction of various waste produced in urban areas. The CO_2 evolution varied with dose and time. Higher the amount of waste generates a greater amount of CO_2 evolution and simultaneously rate of generation of CO_2 greatly decreased with time.

Kalamdhad *et al.*, (2012) had studied the effect of carbon, nitrogen ratio in the quality and duration for composting of MSW generated in urban areas. The CO_2 evolution rate in trail-1 (MSW treated with buffalo manure) and trail-2 (MSW treated with leaves) was greater than that of control which is similar to the present findings.

CONCLUSION

From the experiment, it was found that the dumping of waste has an immense effect on the soil physicochemical properties. With the land-loading of waste, the dumping site soil showed a higher amount of carbon dioxide emission. This may be due to the degradation of organic waste by the microorganisms which ultimately results in CO_2 evolution.

In the present experiment the CO_2 evolution was higher in post monsoon season but the increase trend was started from the monsoon season. CO_2 evolution was maximum in the month of October. In the pre monsoon period i.e., from February to April, progressive trend in CO_2 evolution was found. This might be due to the occurrence of favourable condition i.e., adequate moisture and temperature for the growth of microbial activity. In each site it was found that, the highest CO_2 evolution was seen in MSW dumping sites throughout the year. The possible reason behind this was the stress condition because of increase in heavy organic load which influence the soil microbes for the degradation of organic portion of the municipal waste.

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