Agriculture, Ecosystems and Environment 139 (2010) 74–79

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Influence of pyrite and farmyard manure on population dynamics of soil methanotroph and rice yield in saline rain-fed paddy field

Jay Shankar Singh*, Vimal Chandra Pandey, D.P. Singh, Rana P. Singh

Department of Environmental Science, Babasaheb Bhimrao Ambedkar (Central) University, Raibarelly Road, Lucknow 226025, U.P., India

ARTICLE INFO

Article history:
Received 5 January 2010
Received in revised form 6 July 2010
Accepted 7 July 2010
Available online 31 July 2010

Keywords:
Saline soil
Farmyard manure
Methanotroph
Pyrite
Paddy

ABSTRACT

Influence of farmyard manure (FYM) and pyrite application on methanotroph population and rice yield was examined during July 2008 to October 2008 in rain-fed saline paddy field using a rice variety namely HUR-3010. Four treatment plots with three replicates were established in completely randomized block design. The experimental design consisted of (a) control, (b) FYM, (c) pyrite, and (d) FYM + pyrite. Average methanotroph population was highest in FYM + pyrite treated plot (79.0×10^5 cells g^{-1} dry soil), and lowest in control plot (23.0×10^5 cells g^{-1} dry soil). Regression analysis exhibited negative relationship of methanotroph population with EC ($R^2 = -0.937$) and NH_4^+–N ($R^2 = -0.892$). Rice yield was highest in FYM + pyrite applied plots, while lowest in the control plot. Results suggested that the application of FYM and pyrite singly or in combination significantly enhance the number of soil methanotroph as well as rice yield in the saline paddy field.

1. Introduction

A considerable increase in atmospheric methane (CH_4) during the last century is believed to be responsible for major climate disturbances (IPCC, 2001). CH_4 is the second most important greenhouse gas produced from many sources including paddy fields (Zheng et al., 2008). Before releasing into the atmosphere, the produced CH_4 is subject to oxidation by methane-oxidizing bacteria (methanotroph) in the surface soil layer and the rhizosphere. Measurement of CH_4 in paddy fields indicated that about 60–80% of the CH_4 produced during a rice growing season may be oxidized by methanotroph before it reaches to the atmosphere (Sass et al., 1991; Conrad and Rothfus, 1991). The population size of methanotrophic bacteria (MB) may be one of the important factors that governs the extent of CH_4 consumption in saline or alkaline environments, particularly, the saline rain-fed paddy fields (Khmelenina et al., 2000; Carini et al., 2005). The rain-fed saline paddy fields may assume importance in quantification of the methanotrophs, if substantial amount of CH_4 is consumed by MB in such soils. The methanotrophic communities in aerated soils are the largest biological sink for atmospheric CH_4 (Dalal and Allen, 2008; Dorr et al., 2010). Saline paddy fields are important as salinity is known to affect most of the microbial activities. However, the information about the impact of soil salinity on population size of methanotrophs from saline paddy fields is lacking. Therefore, there are strong reasons to determine the population size of methanotrophs in the rain-fed saline paddy field.

Salinity is known to affect almost half of the world's dry lands, especially paddy fields (Srivastava et al., 2009). In India, the rice growing area is comprised of 42.4 m ha, of which about 25% is infested by salinity rising problems (Tilak et al., 2005). There is general decline in the microbial activities, soil nutrition status and productivity under the influence of soil salinity. Thus, a high salt concentration in paddy soils may lead to a decline in paddy yield and soil microbial flora (Tilak et al., 2005). Population of methanotrophic bacteria constitutes significant component of various types of environments such as saline, hyper saline, wetland paddy soils, soda lakes, tropical rice soils and lake sediments (Khmelenina et al., 2000; Eller and Frenzel, 2001; Kaluzhnaya et al., 2001; Rahalkar et al., 2009; Vishwakarma et al., 2009). However, information regarding methanotroph population in saline paddy fields is unknown despite their prominent role in mitigation of CH_4 load of the atmosphere.

Pyrite application is one of the common amendments used in reclamation of saline soils. Organic manures are considered another important management practice to maintain soil fertility and restoration of saline waste land paddy fields (Saenjan and Sributta, 2002; Yunchen et al., 2009). Watanabe et al. (2009) very recently reported that the continuous application of rice straw compost has positive effects on rice yield as well as on soil physical properties. Since the pyrite application significantly reduces the salinity strength and improves the soil properties of saline paddy fields of upper Gangetic plains (Pandey et al., 2005) and organic amendments are traditional practices for

* Corresponding author. Tel.: +91 9335666104.
E-mail address: jayshankar_1@yahoo.co.in (J.S. Singh).

0167-8809/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.agee.2010.07.003