TEMPERATURE DEPENDENCY OF SOIL DISINFECTION WITH LOW CONCENTRATION OF ETHANOL

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Introduction

Methyl bromide (CH_3Br) was a major fumigant used in Japan to control soil-borne diseases in crops such as cucumbers, gingers, tomatoes, melons, green peppers, etc. The use of CH_3Br as a soil fumigant was phased out in 2005, but no new chemical or non-chemical alternative has yet been commonly used as its substitute. Therefore, areas under cultivation of these crops are decreasing steadily year by year. For now, chloropicrin, 1,3-dichloropropene (1,3-D) and methyl isothiocyanate (MITC) and its generators (dazomet *etc.*) are seen as the best alternatives to CH_3Br. Economically feasible new soil fumigation techniques are desired eagerly by growers.

Reductive soil disinfestations (RSDs) with organic materials such as wheat bran, rice bran or sugarcane molasses are strenuously examined in Japan, but these techniques are limited in the hot season. However, growers strongly desire to carry out soil fumigations in early spring, and this season has such low temperature that it is difficult to apply RSDs with organic materials.

The purposes of our study were to develop the new fumigation technique with low concentration of ethanol solution, and to evaluate adaptivity in cold season such as early spring by inhibiting germination effect of seeds of crop plants and weeds, and the transition of oxidation-reduction potentials (ORP) and oxygen concentration in treated soils.

Materials and methods

Laboratory experiments were conducted to fill up polypropylene containers (15.4 cm in height, 16.0 cm in width and length with an inner dimension, and ca. 3.94 L with an internal volume) with air-dried soils (Hydric Hapludand soil at the NIAES, Tsukuba and Loamy Sand at Tateyama, Chiba), and to sow each 100 seeds of crop plants to depth of 1.0 cm from the soil surface. These seeds were wheat (N61, *Triticum aestivum* L.) and rice (Koshihikari, *Oryza sativa* subsp. *japonica*). Given amounts of diluted ethanol solution (0.0, 0.5, 1.0 and 2.0 v/v%) were applied at a volume of 1.45 L to each container, and this application rate is equivalent to 50 L/m^2. These containers were maintained at 5, 15, 25 and 35 ^oC for 14 days in the incubator. After having removed plastic covers, furthermore for 7 days, these were left at room temperature, and inhibiting germination effects by diluted ethanol solutions were evaluated.

For sequential changes of physicochemical properties of soils by applying diluted ethanol as a soil fumigant, we focused on soil pH, ORP and oxygen concentrations in soil or soil waters. Soil pH and ORP were measured with multiple electrodes (Orion 3-Star Portable pH/ORP/Temperature Meter, Thermo Fisher Scientific, Inc.)

and oxygen concentrations in soils or soil waters were measured with Oxygen Sensor Spectrometer (USB4000-FL-450 Spectrofluorometer and FOXY-T1000-RTD, Ocean Optics, Inc.) consecutively every 30 minutes.

Results and discussion

Water contents of air-dried Hydric Hapludand soil and Loamy Sand were 26.4 and 4.4 %, respectively. In the former soil, amount of soil filled up without compaction is ca. 3,725 g in each container. Under the conditions of temperature equal to or less than 15 ^{o}C, the inhibiting germination effect of wheat seeds was absolutely available with even 0.5 v/v% ethanol solution, but cases of rice seeds were hardly provided. In the condition more than 20 ^{o}C, inhibition of germination for rice seeds increased with a rise of the temperature. This prevention mechanism seems to depend on anaerobic soil disinfestation (ASD), not direct influence of the ethanol. However, with this application amount of ethanol solution (1.45 L), the soil got only wet, not flooded conditions.

The ethanol seems to act as an initiator to the reduction condition of soils and several phase reaction steps take place (Fig. 1). This new fumigation technique has adaptivity in cold season such as early spring, and is promising economically feasible.

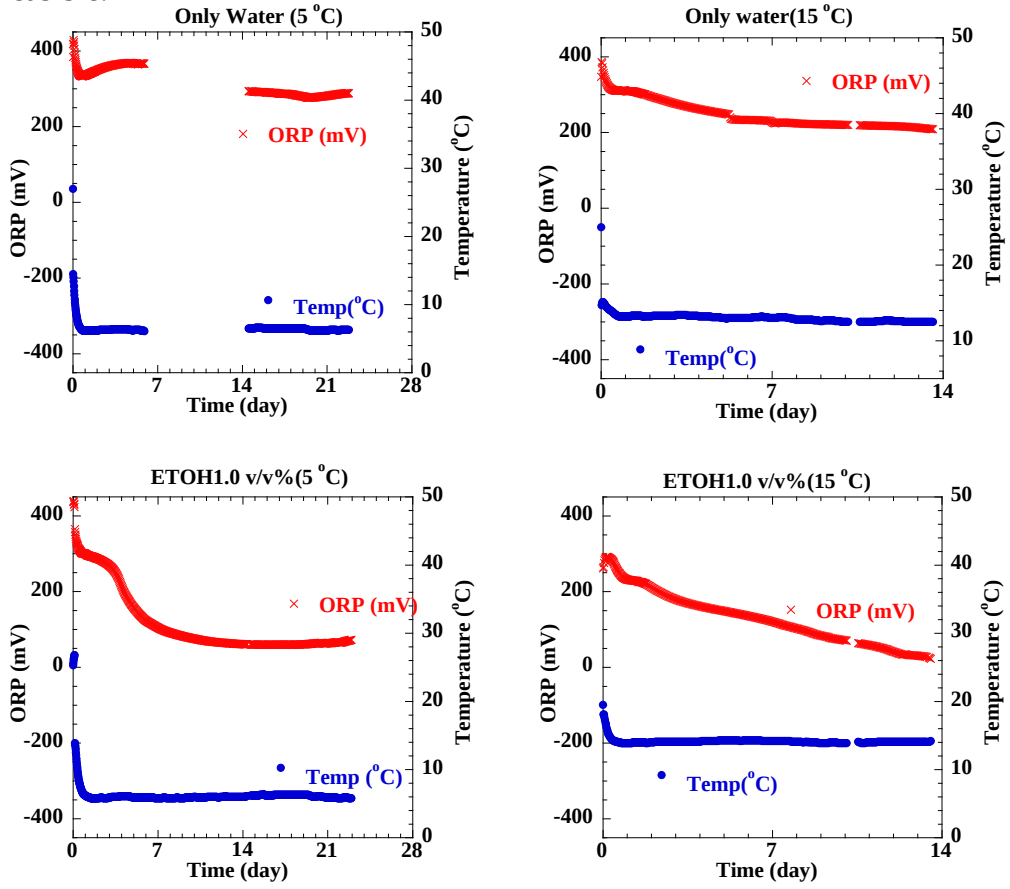

Fig. 1 Oxidation-reduction potential applied with diluted ethanol solution (1.0 v/v%) or only water into air-dried Hydric Hapludand soil