

学 位 論 文 要 旨

Influence of different types of nitrogen fertilizers on nitrous oxide emission and properties of soil and tea leaf
in Japan

日本の茶園における窒素肥料形態が亜酸化窒素発生と土壌及びチャ葉の特性に与える影響

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Two field experiments were conducted to assess nitrous oxide (N_2O) emissions in response to different nitrogen fertilizer types and amounts in heavily fertilized tea fields in Japan.

The first experiment was conducted in Fuchu, Japan. Four treatments were implemented: CONT: no fertilizer, CONV: conventional fertilization, $\frac{1}{2}$ CONV, and CHEM: chemical fertilization. Gas samples were collected 5–8 times after every fertilizer application using the closed chamber method. The results revealed high seasonal variation in N_2O emissions driven by soil temperature rather than the fertilizer application time. The soil temperature at a depth of 0–10 cm was significantly correlated with N_2O emission ($P < 0.01$). The highest cumulative N_2O emission ($73.2 \text{ kg N ha}^{-1} \text{ yr}^{-1}$) was observed in the CHEM treatment, followed by the CONV treatment ($65.0 \text{ kg N ha}^{-1} \text{ yr}^{-1}$), the $\frac{1}{2}$ CONV treatment ($18.6 \text{ kg N ha}^{-1} \text{ yr}^{-1}$) and the CONT treatment ($1.8 \text{ kg N ha}^{-1} \text{ yr}^{-1}$). The highest N_2O emission factor (7.9%) was found in the CHEM treatment, followed by the CONV treatment (7.0%) and the $\frac{1}{2}$ CONV treatment (3.7%). There were spatial differences in the soil characteristics across the tea field. Accurate estimates of the ratios of N_2O emitted from the four treatments during the two crop seasons were 47.9% and 52.1% from the soil on the rows ($108.6 \text{ kg N ha}^{-1}$) and under the canopies ($118.3 \text{ kg N ha}^{-1}$), respectively.

The second field experiment was conducted for 2 years in Green Tea Laboratory of Saitama Prefectural Agriculture and Forestry Research Center, Iruma, Saitama, Japan from March 2014 to December 2015. Controlled release fertilizer (CRF) or organic fertilizer (ORG) was applied with the amount of $450 \text{ kg N ha}^{-1} \text{ yr}^{-1}$ in 2014 and $397 \text{ kg N ha}^{-1} \text{ yr}^{-1}$ in 2015. Nitrous oxide emissions from soil in green tea fields were estimated. The annual cumulative N_2O emissions in CRF were $10.8 \text{ kg N ha}^{-1}$ and $12.8 \text{ kg N ha}^{-1}$ in 2014 and 2015, respectively. The annual cumulative N_2O emissions in ORG treatment were $22.4 \text{ kg N ha}^{-1}$ and $30.0 \text{ kg N ha}^{-1}$ in 2014 and 2015, respectively.

The nitrogen amount applied to the field of $\frac{1}{2}$ CONV treatment in the first experiment was $450 \text{ kg N ha}^{-1} \text{ yr}^{-1}$, which is the same amount applied in the second field experiment in 2014. The cumulative N_2O in the CRF treatments ($10.8 \text{ kg N ha}^{-1}$) was lower than both that in ORG treatment ($22.4 \text{ kg N ha}^{-1}$) and $\frac{1}{2}$ CONV treatment ($18.6 \text{ kg N ha}^{-1} \text{ yr}^{-1}$) in first experiment.

The cumulative N_2O emissions over the 2 years were in $52.8 \text{ kg N ha}^{-1} \text{ 2 yr}^{-1}$ for the ORG treatment which was 2.03 times higher than that of CRF treatment ($25.8 \text{ kg N ha}^{-1} \text{ 2 yr}^{-1}$), and $18.7 \text{ kg N}_2\text{O-N ha}^{-1}$ in CONT treatment. Cumulative N_2O emissions from the entire tea field were 23.6 and $38.5 \text{ kg-N ha}^{-1} \text{ yr}^{-1}$ in row and canopy, respectively. Nitrous oxide emitted from the soil under canopy contributed to 75.4% of the whole emission, this contribution is higher than that of first experiment, due to the width (1.5 m) of canopy in second experiment being wider than that of first experiment (1.2 m).

As a summary, under the same amount of fertilizer application, cumulative N₂O emission was lowest in CRF in the second experiment followed by ORG treatment of the second experiment and the highest value was found in ½CONV treatment of the first experiment. The yield, TN total N content and the quality of tea leaves were not affected by different types of nitrogen fertilizer significantly, however, CRF showed relatively higher values than the other 2 treatments.