

AHW026-04

Room:201A

Time:May 27 15:00-15:15

Quantitative analysis for nitrogen contamination of tea plantation area caused by excess fertilizer

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In this study, it is proposed that nitrate nitrogen concentration of spring and river water is estimated from land use, amount of fertilizer, absorption for plants, and precipitation and then it can be applied for another area. In order to establish an estimation method, spring and river water chemistry, land use for each catchment, amount of fertilizer, precipitation, and flow rate of river were studied at the hilly terrain with tea plantations in Shimizu, Shizuoka city. The nitrate nitrogen concentration estimation method for river and spring water was proposed based on the results.

Estimation method 1

There are three kinds of land use in this area, tea plantation, orange grove and coniferous forest. The measured nitrate nitrogen concentration for spring water at the catchment increased when annual total amount of nitrogen fertilizer was over 20 kg/10a and when the value was less than 20 kg/10a the measured concentration was low. Then the 20 kg/10a was thought to be permissible range for plant absorption. Plant absorption was added for the estimation. Therefore, groundwater nitrate nitrogen concentration for each land use was estimated from each land use area, amount of fertilizer for each land use, absorption for plants and the measured nitrogen concentration for spring water in the catchment. The annual amount of nitrogen fertilizer for tea plantation and orange grove were 54 and 24 kg/10a. The annual absorption for tea and orange were 21.6 and 16 kg/10a. The estimated nitrate nitrogen concentration for tea plantation, orange grove and coniferous forest were 19, 2.8 and 0 mg/l. Nitrate nitrogen concentration at each catchment can be estimated from land use and the estimated nitrogen concentration of groundwater at each land use and in this area, the estimation and concentrations was in good agreement with the measured concentration.

Estimation method 2 : Estimation method 1 + precipitation

Precipitation was not accounted in the estimation 1. When the precipitation was different, the estimation 1 can not be applied for another field. As most of nitrogen fertilizer was ammonium sulfate and it was directly sowed on the ground, then, it was proposed that fertilizing nitrogen was diluted by precipitation on the ground and some water directly flowed on the slope and others infiltrated. The infiltrated nitrogen was absorbed by plants in the ground. Then, estimation 2 was as follows.

$$\text{Nitrate nitrogen concentration} = (\text{amount of nitrogen fertilizer} \times \text{infiltration rate of precipitation} - \text{absorption by plants}) / [(\text{precipitation} - \text{evapotranspiration}) \times \text{infiltration rate of precipitation}]$$

The nitrate nitrogen concentration estimated by estimation method 2 was in good agreement with the measured concentration. In this area, 13 % nitrogen of the amount of nitrogen fertilizer sowed on the ground directly flowed on the ground and 87 % nitrogen of the amount of nitrogen fertilizer sowed on the ground infiltrated into ground and some nitrogen was absorbed. 11 % of water for infiltrated water was deep groundwater.

Keywords: tea planation, fertilizer, nitrogen contamination