Lowering of rhizosphere soil pH is a relevant factor on biological nitrification inhibition in sorghum

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the major food crops in the world. To date, most studies on biological nitrification inhibition (BNI) in sorghum have been performed on plants grown in hydroponic systems. To determine whether or not sorghum inhibits nitrification in fields, this current study was conducted in an area underlain by alfisols, which is a typical soil in semi-arid and sub-humid tropics, with the aim of clarifying the mechanism that results in the inhibition of soil nitrification in the field. Nitrification activity in the rhizosphere of sorghum, i.e., the soil (of a few millimeters thick) surrounding the roots, was measured and compared with those in the adjacent bulk soil.

Sweet sorghum (CSH 22SS, NTJ 2, 675x700, ICSV 25263, ICSV 25274, ICSV 93046) and grain sorghum (CSH 16, PVK 801, HTJH 3201) were cultivated in four alfisol fields in the semi-arid tropical region of India during the 2010 and 2011 rainy seasons. Soil samples were collected three times during the growing season. Nitrification activity in the rhizosphere soil was significantly lower than that in the bulk soil in 8 out of 12 samplings (Fig. 1a), while the pH (H_2O, 1:2) of the rhizosphere soil was significantly lower than that of the bulk soil in 10 out of 12 samplings (Fig. 1b). The nitrification activities and soil pH showed significant positive correlation for Alfisols 3 and 4 except for Alfisol 3 at 98 days after sowing, whereas the nitrification activity and soil pH had significant positive correlation for Alfisols 1 and 2 collected during the mid and late growth stages in the four fields (Fig. 2). Acidification of the soil by sulfuric acid decreased the nitrification activity to a comparable extent, as observed in the rhizosphere soils (Fig. 3).

These results indicate that acidification of soil around roots would be one of the main causes of nitrification inhibition by sorghum in the field. Although our study showed that acidification of soil would be the main driving force for nitrification inhibition in the rhizosphere, root exudates such as sorgoleone may also enhance BNI simultaneously. Due mainly to technical difficulties involving soil, which contains numerous and wide-ranging organic compounds, it remains unclear whether specific compounds exudated from plants inhibit nitrification in the soil-plant system. Further studies are necessary to clarify the contribution of root exudates to BNI activity in the field.

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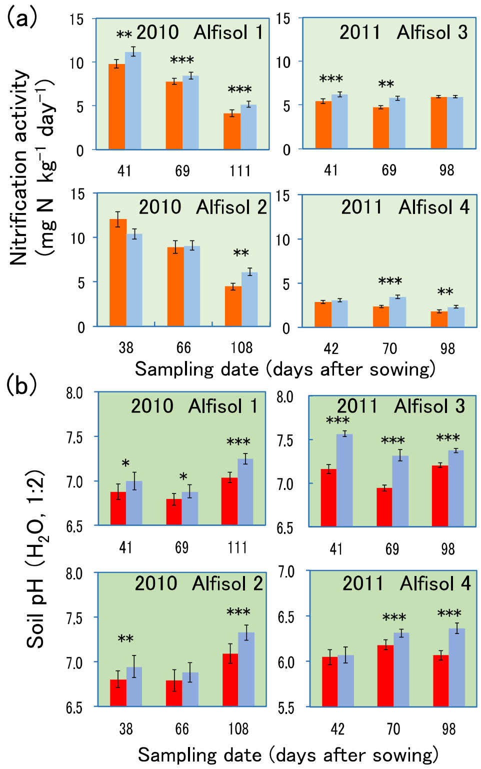

Fig. 1. Average nitrification activities (a) and average pH (b) in the rhizosphere soils (■, ■) and bulk soils (■, ■) in each sampling

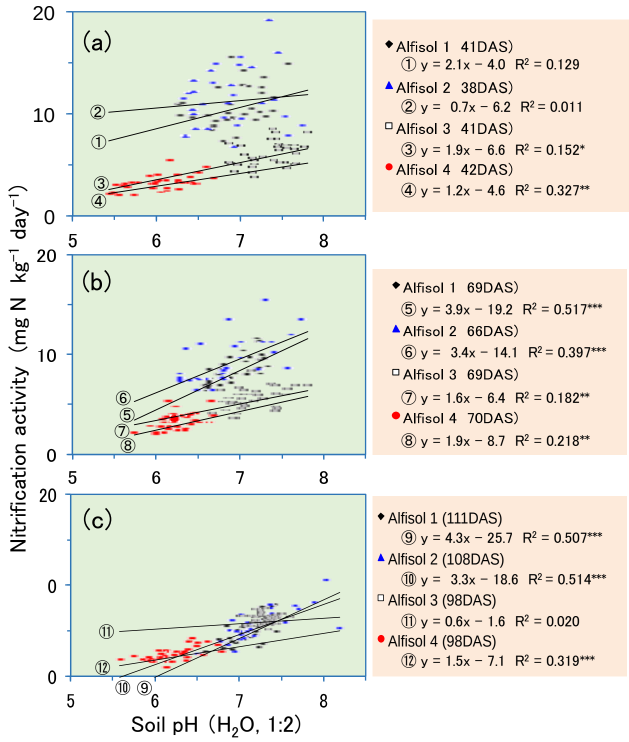

Fig. 2. Relationship between nitrification activity and soil pH (H_2O, 1:2) of rhizosphere soil in each sampling (early (a), middle (b), and late (c) stage of growth)

DAS: days after sowing

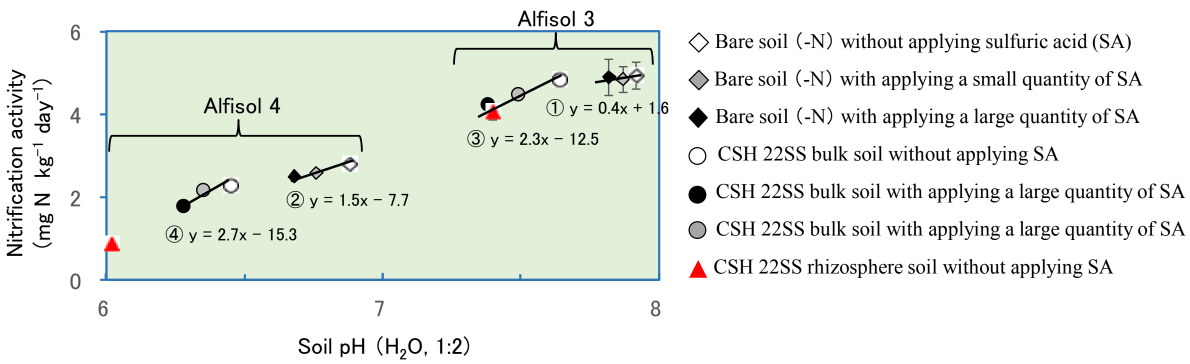

Fig. 3. Effects of soil pH modification on nitrification activity

Each nitrification activity of soils with modified soil pH by applying sulfuric acid was measured.