Effect of ammonium nitrogen and ferrous iron in soil solution on tiller number of rice at early growth stage

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ABSTRACT

We evaluated the regional-scale variation of early growth of rice grown on alluvial paddy fields. No relation between the tiller number at early growth of rice and the amount of extracted Fe^{2+} in soil was observed, although the amount of Fe in soil solution ranged from 2 to 140 mg L^{-1}. Increase of the amount of NH_4^+-N in soil solution increased the tiller number of rice. The amount of NH_4^+-N was related to the ratio of the charge of NH_4^+-N or Fe^{2+} to CEC. Increasing of extracted Fe^{2+} in soil inhibits rice growth and increases the level of NH_4^+-N in soil solution.

INTRODUCTION

Site-specific nutrient management on a regional scale is important for efficient and ecological crop production (Vetsch et al. 1995). Nutrients in soil solution had large influence on early rice growth. Although soil NH_4^+-N is the most important nutrient to control rice growth (Wada et al. 1989), Fe^{2+} also acts importantly throughout all stages of rice growth. Early rice growth is inhibited by Fe^{2+} in soil solution when it is more than 50 mg L^{-1} (Tadano 1976). The objective of this study was to clarify the relation between the amount of NH_4^+-N and Fe^{2+} in soil solution and the tiller number of rice at the early growth stage grown in Tsuruoka City, located on the Shonai Plain in northeastern Japan.

MATERIALS AND METHODS

Field experiments were conducted in 19 fields in 1998 and in 35 fields in 1999. Cultural practices were followed by conventional methods of each field. Rice seedlings (cv. ‘Haenuki’) were transplanted manually in the middle of May, in both years. The tiller number of rice was counted and soil samples were taken at a depth of 0-10 cm at 20 days after transplanting (DAT). The amount of extractable NH_4^+-N was measured by the steam-distillation method after extraction with 1 M KCl at pH 7.0 and Fe^{2+} was measured by the *o*-phenanthroline photometric method using the soil solution extracted by 1 M NaOAc at pH 3.0. The soil solution was collected by centrifuged method in order to evaluate the amount of NH_4^+-N in soil solution determined by the indophenol blue photometric method. To determine the amount of Fe in soil solution, the soil solution was collected on 12 June in 2000 from the same fields as in 1999 by sucking method using a porous-cup at a depth of 0-4 cm, and Fe content was measured by the *o*-phenanthroline photometric method.

RESULTS AND DISCUSSION

Fe content in soil solution ranged from 2 to 140 mg L^{-1}, which is sufficient to inhibit rice growth at the early growth stage. However, the differences in the tiller number among fields at 20 DAT did not relate to the amount of extracted Fe^{2+} from soil (Fig. 1). The amount of NH_4^+-N in soil solution might affect the tiller number of rice at 20 DAT (Fig. 2) (Sasaki et al. 2002). The amount of extracted NH_4^+-N or cation exchange capacity (CEC) in soil contributed to the amount of NH_4^+-N in soil solution when the other parameter was constant (Ando et al. 1988). In this study, no relation between the amount of NH_4^+-N in soil solution and CEC or the amount of extracted NH_4^+-N in soil was observed. The ratio of the electric charge of extracted NH_4^+ to CEC and of extracted Fe^{2+} to CEC affected the amount of NH_4^+-N in soil solution. Thus, increasing extracted Fe^{2+} in soil has a negative and positive effect on the tiller number of rice simultaneously. The negative effect is the inhibition of rice growth caused by increased Fe in soil solution, and the positive effect is promoting rice growth because of increased NH_4^+-N in soil solution. This study was carried out on alluvial paddy soil during the early growth stage of rice. The amount of extracted NH_4^+-N and Fe^{2+} might correspond to deny the positive and negative effects, and then the tiller number of rice at 20 DAT would have no relation with the amount of extracted Fe^{2+} in soil. It can be considered that in other soil types or other environmental conditions much more extracted Fe^{2+} exists comparing the amount of Fe^{2+} and NH_4^+-N of this study. In these situations, the effect of Fe in soil solution on early rice growth should also be considered with the balance of NH_4^+-N and CEC in soil the same as in this study.

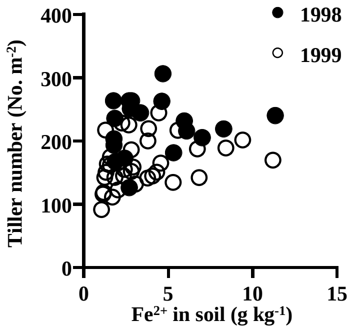

Fig. 1. Relation between the amount of extracted Fe^{2+} in soil and tiller number of rice at 20 DAT.

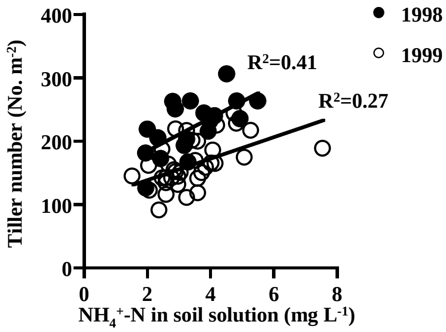

Fig. 2. Relation between the amount of NH_4^+-N in soil solution and tiller number of rice at 20 DAT.

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