Effect of water management on root activities, N uptake and yield of rice

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Introduction

Continuous flooding causes the soil to become increasingly anaerobic with low redox potential. Depending on soil physico-chemical properties, these conditions cause adverse effects on root development and activity, including reduction in number and diameter of lateral roots; root respiration; root oxidative power; root damage and rots due to reduced products of Fe^{++} and H_2S in the increasing order of severity. These adverse effects on roots cause reductions in stomatal conductance, photosynthesis, leaf longevity and yield. For minimizing those adverse effects of continuous flooding on rice, and for increasing the yield various kinds of water management methods have been practiced by farmers and investigated by researchers , including mid-season drainage, delayed flooding, shallow water management, intermittent irrigation, alternate wetting and drying systems (AWD) etc.

Materials and Methods

Two field experiments were conducted to evaluate the effect of water management on root activities, N uptake and yield of rice. Water regimes applied were flooded (5 cm above the soil surface), early mid-season drainage (EMSD) (drained water from DAT 26 to 36) and mid-season drainage (MSD) (drained water from DAT 36 to 46). Another water regimes applied were shallow wider spacing (30cm x 30cm), shallow narrow spacing (30cm x 15cm), conventional wider spacing (30cm x 30cm) and conventional narrow spacing (30cm x 15cm). In conventional method, 5-6cm ponding water depth was maintained throughout the growing period except for MSD and totally drained out 15 days before the harvest. For shallow water, ponding water depth of 1-2 cm with wetting and drying was done till panicle initiation stage and then 1-2 cm was maintained and totally drained out 20 days before harvesting.

Results

In experiment I, the trend of respiration rate was higher in MSD (6.3 mg CO_2 g^{-1} h^{-1}) than EMSD and flooded treatments at 46 and 53 DAT. The xylem exudation rate was higher in MSD (2.04 g $hill^{-1}$ h^{-1}) than EMSD and flooding treatments during 46 and 95 DAT. Nitrogen accumulation in plant was larger in MSD treatment during the drainage period and had no statistically significant differences. The brown rice yield of MSD (653 g m^{-2}) treatment was larger than flooded (635 g m^{-2}) and EMSD (623 g m^{-2}) treatments. Root physiological activities in MSD tended to be higher than those in continuous flooded condition. For dolomite application plot, among the treatments (flooded, EMSD and MSD) had no significant differences. These result indicated that dolomite application did not affect root physiological activity directly but drained (MSD) condition had significant effect.

In experiment II, respiration rate of shallow water management ranged from 0.88 to 4.36 mg CO_2 g^{-1} h^{-1} where conventional water management ranged from 0.76 to 3.83 mg CO_2 g^{-1} h^{-1}. Xylem exudation rate of shallow water management ranged from 2.08 to 2.8 g $hill^{-1}$ h^{-1} where conventional water management ranged from 1.38 to 2.73 g $hill^{-1}$ h^{-1}. Root volume ranged from 0.22 to 1.45 mg cm^{-3} on shallow water management where conventional water management was ranged from 0.2 to 1.18 mg cm^{-3}. Respiration rate ranged from 0.76 to 3.83 mg CO_2 g^{-1} h^{-1} on wider spacing where narrow spacing ranged from 0.69 to 4.06 mg CO_2 g^{-1} h^{-1} and statistically had no significant differences. Xylem exudation rate ranged from 2.08 to 2.8 g $hill^{-1}$ h^{-1} on wider spacing where the narrow spacing ranged from 2.26 to 3.12 g $hill^{-1}$ h^{-1} and had no significant differences. Root mass density ranged from 0.22 to 1.45 mg cm^{-3} on wider spacing where incase of narrow spacing the root mass density ranged from 0.25 to 0.94 mg cm^{-3}. Shallow water management could be helpful for root physiological activity such as respiration, xylem exudation rate and root mass density at early growth stage which ensure better growth and yield performance at later stage. For incase of plant spacing between the treatments (conventional and shallow water management) had no significant differences. These findings of this study suggest that plant spacing (either wider or narrow) did not affect the root physiological activity directly but water management (shallow water management) had positive effect.