PERFORMANCE OF RICE ON A COARSE SANDY LOAM SOIL IN RESPONSE TO WATER-SAVING IRRIGATION PRACTICES IN LOWLAND EASTERN INDONESIA.

Ahmad Suriadi[1,4], Rabi Misra[1], Donald Gaydon[2] and Yahya Abawi[3]
[1)] Faculty of Engineering and Surveying, University of Southern Queensland, Toowoomba, QLD 4350, Australia, Suriadi@usq.edu.au
[2)] CSIRO Sustainable Ecosystem, St Lucia, QLD 4068, Australia
[3)] Queensland Climate Change Centre of Excellence, Department of Environment and Resource Management, Toowoomba, QLD 4350, Australia
[4)] Assessment Institute for Agricultural Technology (BPTP), PO Box:1017 NTB 83010, Indonesia

INTRODUCTION

Rapid increase in world population and a corresponding increase in demand for water and land from industrial and municipal have forced the agricultural sector to use marginal land and irrigation water more efficiently by using less water to produce more food. Coarse-textured and porous soils of the tropical regions are increasingly used for growing both upland and lowland rice. In porous soils under rice, continuous flooding cannot be maintained due to high water percolation rates. Development of appropriate planning and management strategy to improve available water resources for the agricultural sector is a high national and global priority. Increased efficiency in water use is essential for future food security in Asia where rice production needs to increase by 70% over the current production by the year 2025 (Tuong and Bhuiyan 1999). However, experimental evidence for the hydrological and environmental conditions of coarse soils under which current rice-based cropping systems are practiced is limited. Such studies will become more important as porous soils are increasingly used for irrigated rice-based cropping systems. In this paper, we evaluate the effectiveness of alternately submerged and non-submerged (ASNS) over continuously submerged (CS) irrigation practices using three years of field experimental data on a coarse soil in the tropical region of eastern Indonesia.

MATERIALS AND METHODS

The experiment was based on a split-plot design consisting of three replications of two irrigation treatments (CS and ASNS) as main plots and three rates of N fertilization of 0 (F0), 69 kg N ha^{-1} (F1) and 138 kg N ha^{-1} (F2) as subplots within each main plot at an experimental station of BPTP NTB Indonesia (08°35’ N, 116°13’ E and 150 m elevation). Phosphorus and potassium fertilizers were applied at rates of 100 kg TSP ha^{-1} and 50 kg KCl ha^{-1} before transplanting of rice. All N-fertilizer applications were split into 20% at 7 days after transplanting (DAT), 30% at 29 DAT, and 50% at panicle initiation (45-50 DAT). For both CS and ASNS irrigation treatments, ponded water depth in the field was maintained between 0-20 mm during the first 7 DAT and was drained at 10 days before harvesting. For the CS treatment, ponded water depth was allowed to fluctuate between 0-100 mm throughout the growth period. Plots under ASNS treatment remained without submergence for around 5–7 days depending on rainfall conditions. Daily weather data were collected from a weather station at the experimental site. Crops were sampled for yield, biomass and N uptake at harvesting and analysed using Genstat Software (Version 9.2.0.153, VSN International Ltd, Oxford).

RESULTS AND DISCUSSION

Daily rainfall and ponded water depth (D) in the field for CS and ASNS treatments are shown in Figure 1 for 2007-09 rice growing seasons. Values of D were within the range of 0 to 99 mm and -79 to 59 mm for CS and ASNS, respectively. Negative value indicates water depth below soil surface. Percentage of days without ponding in ASNS was 23%. Total amount of irrigation water applied over three years to CS and ASNS during rice growing season was 1080-1820 mm and 664-1104 mm, respectively. Amount of water saved during rice growth with ASNS compared to CS irrigation was 36-46% during 2007-09. Rainfall during rice growth was 1029, 233 and 897 mm for 2007, 2008 and 2009, respectively. Mean percolation rate over three years for the experimental site was10.1 mm per day.

This study indicates that the ASNS treatment on coarse soil did not lead to very dry soil conditions during the nonsubmergence periods although there was water saving of 36-46% compared with CS treatment, biomass, yield and components of yield did not significantly differ between ASNS and CS (Fig. 2). Significant differences in yield and yield components with N rates but not with water regimes, is consistent with previous studies (Bouman and Tuong, 2001; Belder et al., 2004; Qi Jing et al., 2007). Success with alternate submergence and non-submergence conditions in ASNS treatment was due to soil remaining close to saturation in which water depth did not drop to 10 cm below the soil surface (Fig. 1). Similar results have been reported by Belder et al. (2004) for a clay soil with a shallow water table and percolation rates of 1-4.5 mm per day. Absence of any significant reduction in yield and biomass due to the direct effects of irrigation treatments and lack of significant interactive effects with N-treatments suggest that these results appear to be typical for well-drained, irrigated lowlands in eastern Indonesia and ASNS practices can results in considerable water-saving without adversely affecting yield.

ACKNOWLEDGMENTS

This research is funded through a scholarship provided by the Australian Centre for International Agricultural Research.

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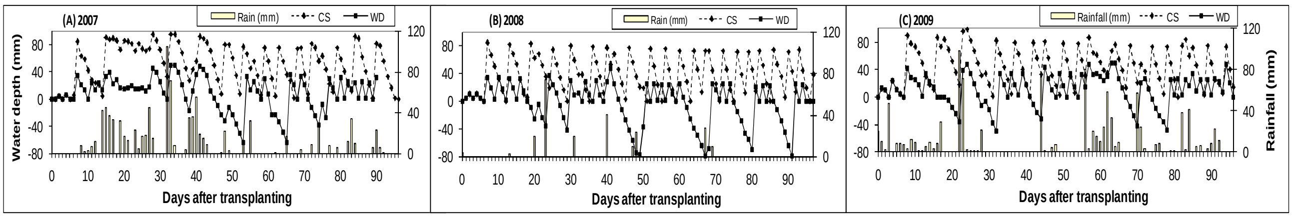

Figure 1. Water depth and rainfall in CS and ASNS water regimes during rice growing seasons in 2007 (A), 2008 (B) and 2009 (C).

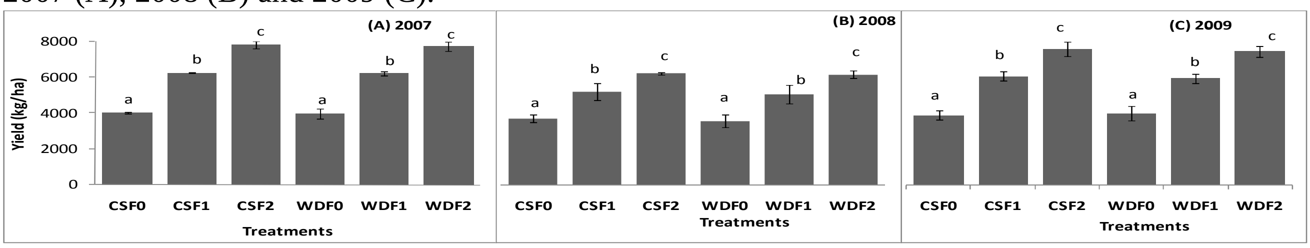

Figure 2. Effect of water regimes (CS and ASNS) and N fertiliser (F0, F1 and F2) on grain rice yield.