Do Alternate Wetting and Drying Irrigation Technology and Nitrogen Rates Affect Rice Sheath Blight?

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Abstract

Water and nitrogen management play vital roles in rice production. However, the mismanagement of these two management practices may trigger sheath blight of rice, caused by *Rhizoctonia solani*, which is favored by wet conditions, high relative humidity, and high nitrogen fertilizer levels. To understand how different combinations of water and nitrogen management affect sheath blight epidemics, we conducted two separate split-plot experiments with a water saving (alternate wetting and drying) regime and traditional flood irrigation regime combined with differing nitrogen treatments in the dry seasons of 2015 and 2016. Disease was scored in the same way in both experiments using a sheath blight assessment scale for field evaluation developed at the International Rice Research Institute to assess the severity on infected sheaths and leaves while sheath blight incidence on tillers were counted per hill. We were unable to detect any differences in disease in either experiment due to irrigation regime, N rates or the interaction of the two treatments in either season. This suggests that farmers can adopt water saving technologies without risking increased sheath blight incidence. We suggest that further cross-cutting research in this area is warranted.

1 Introduction

Alternate wetting and drying (AWD) is an irrigation technique for irrigated rice developed by the International Rice Research Institute (IRRI) and its partners that saves about 15-40% of irrigation water (B. Bouman and Tuong 2001; L. Feng et al. 2007). In AWD rice fields are exposed to several dry phases during the growth period without exposing the plants to water stress. In order to avoid yield decline under AWD "safe"

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thresholds have been developed. Under safe AWD irrigation water is applied when the field water level reaches 15cm below the soil surface (Richards and Sander 2014). Fields are furthermore kept flooded during the flowering period. Besides saving water AWD also reduces greenhouse gas (GHG) emissions of rice fields, which is a substantial factor in the GHG budget of rice producing countries, by around 50% (Yan et al. 2005; Sander, Wassmann, and Siopongco 2016).

The AWD technology has been identified as promising climate smart practice for different rice growing regions that can stabilize rice production in water scarce areas as well as help reduce the carbon footprint of rice production. Various countries, *e.g.*, Bangladesh, Vietnam, Thailand and the Philippines, plan to widely apply AWD to local rice production (Environment and Government of the People's Republic of Bangladesh –). However, a change in water regime in rice fields on large scale might encompass different other effects, for example related to plant health.

We therefore established field experiments in order to…

2 Materials and Methods

2.1 Experimental Design

Two experiments were conducted at the International Rice Research Institute's (IRRI) Ziegler Experiment Station in Los Baños, Calabarzon, Philippines (latitude 14° 11' N, , longitude 121° 15' E) in the 2015 and 2016 dry seasons. For the 2016 season changes were made to optimize the experiment based on findings from the 2015 season. Both seasons consisted of split plot design with four replicates where irrigation was the main plot and nitrogen (N) rate was the split plot treatment. The changes between seasons and experiments are detailed following.

2.1.1 2015 Dry Season

The main plot size was 12m x 12m (144 sq m), with a sub-plot size of 5m x 5m (25 sq m). Replication size was 12m x 24m (288 sq m) with a buffer of 1m per sub plot for a whole experiment size of 1,152 sq m. The main plot treatments were alternate wetting and drying (AWD) and) and continuously flooded (CF) or farmers' practice.

Irrigation in AWD plots was determined by the water level in plots, *i.e.*, when the water level reached 15cm below the soil surface irrigation water was applied to a level of 5cm. In CF plots a standing water layer of

3-5cm was maintained throughout the growing season.

The subplot treatments were different rates of nitrogen, 0 kg/ha (control), 100 kg/ha in three splits, and 120 kg/ha in three splits.

The plots were inoculated 20 days after transplanting using 151g of inoculum per plot (4m x 11m).

2.1.2 2016 Dry Season

In 2016 dry season the plot size was increased and due to these changes, the sizes of the replicates are not equal as necessitated by the use of a larger area for the experiment. The main plot sizes were: Block 1 (B1) 21m x 20.5m (412.5 sq m) and Block 2 (B2) 20.25m x 21.6m (437.4 sq m). The sub plot sizes were B1 21m x 10.25m (215.25 sq m), B2 20.25m x 10.8m (218.7 sq m). The replication sizes were B1 - 42m x 20.5m (861 sq m) and B2 - 40.5m x 21.6m (874.8 sq m). A buffer 0.5m per sub plot was used and the overall experiment size was 3471.6 sq m.

Subplot N rates differed from the 2015 rates. The control was applied as 60 kg/ha split into two applications and a second treatment of 180 kg/ha in three splits was applied.

Based on the 2015 results, the inoculation methods were modified in 2016 to increase the amount of inoculum applied to a smaller area. Plots were inoculated 41 days after transplanting using ten bottles per one sampling area (1m x 1m) per plot, where one bottle contained 151g inoculum. A total amount of 1,510g of inoculum was applied to a 1m x 1m area.

2.2 Data Collection and Analysis

Disease scoring was the same in both experiments using a sheath blight assessment scale for field evaluation developed at IRRI 1. Two sample areas per plot (1m x 1m) were assessed. for 9 hills per sample, the number of tillers per hill and number of tillers with sheath blight (incidence) were measured. Tiller sheath blight severity was measured for four tillers per hill and six leaves tiller. Five and four disease assessments were made in 2015 and 2016, respectively.

[Figure 1 about here.]

Disease severity was converted to area under the disease progress stairs (AUDPS) (Simko and Piepho 2012). As most of the data did not meet assumptions for normality, the analysis was carried out using multivariate generalised linear mixed models implemented in the MCMCglmm package (Hadfield 2010) in R (R Core

Team 2017).

3 Results

3.0.1 Tiller Sheath Blight Incidence

In 2015 both the nitrogen rates, N100 and N120, were significant when compared with the base N0 rate, water management was not significant.

In 2016 the nitrogen rate N180, was significantly different than the base N60 rate, water management was not significant.

3.0.2 Tiller Sheath Blight Severity

In 2015 both the N100 and N120 rates were significantly different than the N0 treatment. The AWD water management was also significantly different from the base flooding treatment.

In 2016 the N180 was significantly different from the N60 rate. The AWD water management was also significantly different from the base flooding treatment.

3.0.3 Leaf Sheath Blight Severity

In 2015 both the N100 and N120 rates were significantly different than the N0 treatment. The AWD water management was also significantly different from the base flooding treatment.

In 2016 the none of the treatments, nitrogen rate or water management, were significantly different from the base treatment for leaf sheath blight severity.

4 Discussion

5 Acknowledgments

References

Supporting information captions (if applicable)

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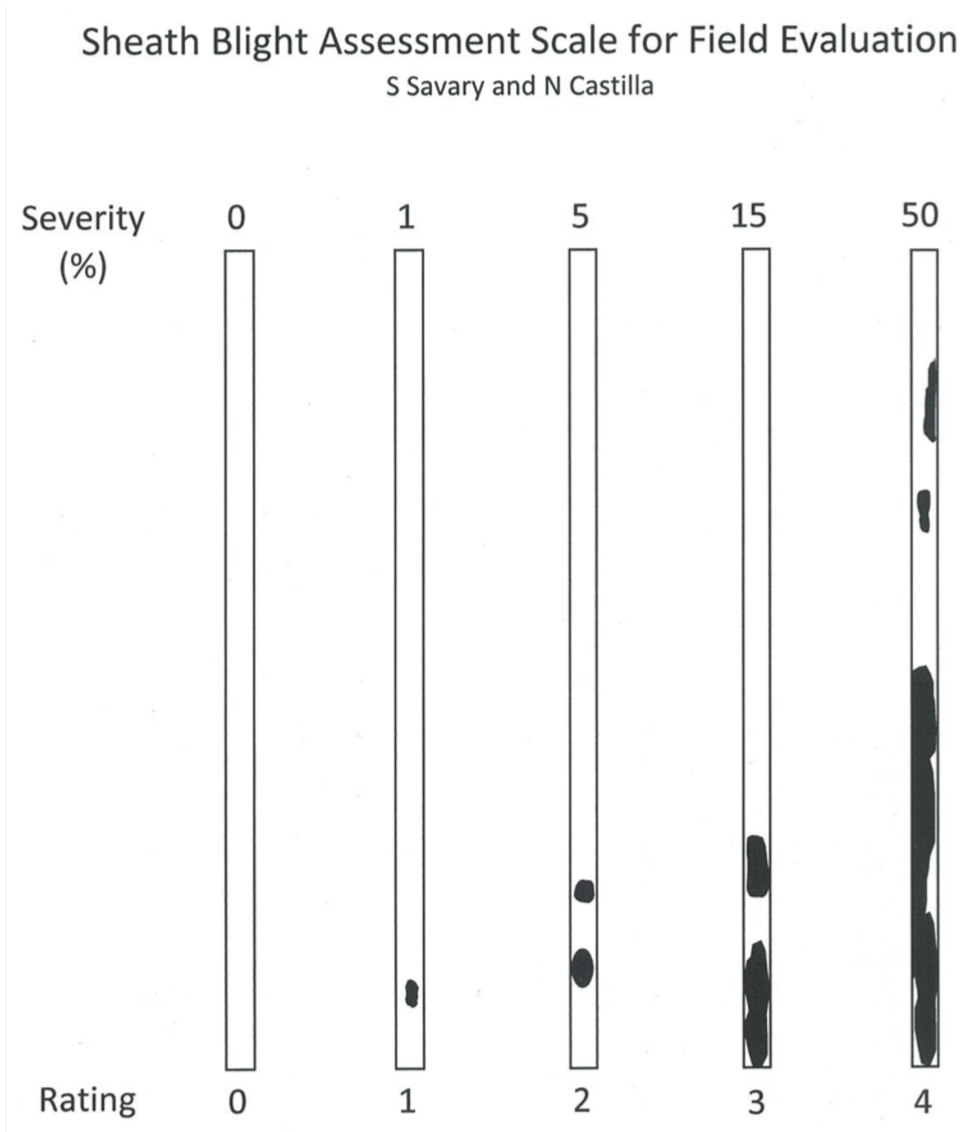

Figure 1: IRRI sheath blight field severity rating scale where, 0 - 0%, 1 - 1%, 2 - 5%, 3 - 15%, 4 - 50%, 5 - >50%.