Rice Technical Working Group

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PROCEEDINGS. . .

Thirty-Seventh Rice Technical Working Group

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A multi-year study was conducted to evaluate rice cultivars and germplasm under precise deficit irrigation regimes using a subsurface drip irrigation system. The goal of this investigation was to identify cultivars that possess water-deficit stress tolerance with minimum yield penalty and to understand the biochemical and physiological nature of selected germplasm. Field trials were conducted using a randomized complete block design at DBNRRC/UofA research farm (N 34.46286°, W 91.39944°) for three years (2014-2016). A total of 15 rice cultivars representing a diverse genotypic range (indica, japonica, long grain, and medium grain) were evaluated in a replicated trial using four soil moisture regimes: Treatment 1: fully saturated (field capacity, FC), Treatment 2: 30% deficit, Treatment 3: 70% deficit, and Treatment 4: just above the wilting point. Two-row plots were drill planted each year (May-June) in such a way that the buried drip tape was between the two rows in the plot. To prevent water exchange between the treatments, 4 buffer rows of rice (cv. RoyJ) were planted between the irrigation treatments. Fertilizer and herbicide was applied according to local rice agronomic practices. Plots were thinned to a uniform plant stand and two-four seedlings were selected in the middle of the row and tagged for season-long defined measurements. Plots were fully irrigated until the V5 stage when irrigation treatments were initiated. To target certain soil moisture levels for each treatment, the irrigation valves were automatically controlled based on Acclima water moisture sensors, which were placed in rhizosphere of each treatment at 20 cm depth. Throughout the season actual soil moisture was monitored on each plot through a portable soil moisture sensor.

On average, the total amount of irrigation applied in the most saturated treatment was 68.98 ha-cm compared to 36.34 ha-cm in the greatest water deficit treatment. Overall water-deficit stress treatments reduced plant height (91 cm to 79 cm), delayed heading dates (89 days to 93 days), and reduced grain yield per plant (26.5 g to 14.4 g) compared to the FC treatment. Regression analyses of the data support the developing hypothesis that the yield under water-deficit environment could be governed by thousand kernel weight trait. The cultivars were ranked for yield per se, and for yield stability across the four water regimes. In the final year of the study, foliar ascorbic acid (AsA) measurements were determined approximately 17 days before heading to evaluate the association between AsA and water-deficit stress tolerance. A selected set of genotypes were evaluated for net photosynthesis, stomatal conductance, and evaporation at this same stage. Based on the results an association was established between AsA, stomatal conductance, and yield under water-deficit stress tolerance and will be presented. The data supports that SDI is a viable and effective method for germplasm evaluation at a targeted water-deficit stress level. The study revealed that two mapping populations available at DBNRRC (PI 312777 x Katy, and Lemont x Teqing) are the best choices to screen under 20-40% water deficit conditions, while Rondo x Francis mapping population could be an excellent choice for higher water-deficit stress conditions and to look for transgressive variants among the mapping population.

Strategies to Minimize Water Used While Maintaining Grain Yields in Uruguayan Rice Systems

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Water is a limiting factor for the expansion of rice crops as a high proportion of rice irrigation in Uruguay is done with water stored in dams. Irrigation management practices that increase water productivity (more or equal rice produced per volume of water used), would lead to an increase of rice planted area per year. Moreover, a reduction of water used to irrigate rice would allow to allocate water to irrigate other crops in a crop rotation and could reduce pumping irrigation costs. Improving water use efficiency would also allow farmers to irrigate properly the entire rice planted area during all the crop cycle, while minimizing risks and securing rice yield potential. The aim of this study was to determine irrigation management practices and field layout techniques that increase Water Productivity (WP) allowing a reduction in water used without negatively affecting grain yield. A summary of the joint analysis results of experiments carried out during three seasons (2011-2014) in three rice growing regions: East (Treinta y Tres), North (Artigas) and Center (Tacuarembó) are presented in this work.

A split plot experimental design trial was conducted in North and Central regions. Treatments included two types of systematization with different vertical (VI) interval between levees (big plots): I. Conventional (VI-8cm) and II. Alternative (VI-4cm), and three irrigation management practices (small plots): 1.Continuous (C), 2.Intermittent until panicle initiation (IP) and 3.Intermittent during all crop cycle (I). A complete randomized block design was conducted in the East region. A total of five treatments were evaluated; three continuous flooding treatments: flooding at 15, 30 (control) and 45 days after emergence (C15, C30 and C45) and two controlled irrigation treatments: intermittent irrigation (IP) and alternate wetting and drying (AWD). In C a water layer of 10cm is maintained after flooding throughout all the crop cycle. In IP and I the water layer is allowed to decrease and is re-established when the soil is still saturated. The AWD, alternates wetting and drying periods until panicle initiation, allowing a 50% depletion percentage of the available soil water in the first 30 cm depth (equivalent to 25 mm of water for this Brunosol soil), determined through a water balance using information from a weather station and soil tensiometers installed in the experimental area.

Intermittent irrigation (IP and I) led to a significant savings in water inputs in both North and Central regions (38%-5,567 m^3water ha^{-1} and 35% -2,798 m^3 water ha^{-1} respectively)) and a significant increase in water productivity. Considering only water from irrigation, WP was: 0.57(c), 0.73(b) and 0.88(a) (kg grain m^3 of $water^{-1}$) for C, IP and I respectively in the North. In the Central region WP was 0.99(c), 1.31(b), 2.00(a) kg grain m^3 of $water^{-1}$ for C, IP and I respectively ($P< 0.05$). Intermittent irrigation (IP and I) affected negatively industrial quality in both regions while grain yield was reduced (950 kg rice ha^{-1} less) only in the North. However, grain yield was not affected in low-infiltration rate soils (planosols) of Central Region (average = 7713 kg rice ha^{-1}). Regarding systematization, there were no significant differences in any of the parameters evaluated between treatments in the North and Central regions ($P <0.05$). The higher yields registered in the East region were obtained in the treatments CF15, CF30 and IP (10,592(a), 10,454(a) y 10,189(ab) kg ha^{-1}, respectively), followed by CF45 and AWD (9,653(bc) y 9,287(c) kg ha^{-1}, respectively) ($P< 0.05$). Mean irrigation water productivity was 1.31 kg of rice m^{-3} ranging from 1.18 (CF45) to 1.46 kg m^{-3} (AWD). Mean irrigation water used was 6150, 8044 and 10968 m^3 ha^{-1} in the Central, East and Northern region respectively.

This study helped to identify irrigation management practices that reduce water used while achieving high water productivity values. Intermittent irrigation (IP) during vegetative phase until panicle initiation in low infiltration soils (East and Center), reduced water used without affecting grain yield. Further research and validation is required in order to evaluate water Management strategies that maintain soil water depletion in a range that does not reduce rice grain yields and quality in both, experimental conditions and commercial farms.

Subsurface Water Losses: Seepage and Percolation in California Rice Fields

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California rice fields receive 135 cm of applied water on average, more than almost any other crop grown in California. However, the evapotranspiration or consumptive water use by rice is similar to many other crops (approximately 85 cm). This discrepancy between applied water and consumptive water use is due to variable tailwater drainage as well as seepage and percolation losses. Here we define percolation as downward water movement below the root zone and seepage as lateral water movement at the borders of a rice field. Given the growing pressure to reduce agricultural water use, it is important to understand and quantify these subsurface water loss pathways.

In this study, we quantified seepage and percolation using (1) direct measurements of water loss from replicated percolation rings installed in eight fields, (2) direct measurements of water loss from nested three-sided metal seepage frames installed in different levee types at six fields, and (3) complete water balances for three commercial rice fields. Our results show that percolation is consistently low throughout the Sacramento Valley, ranging from less than 0.75 cm per season to approximately 5 cm per season. Lateral seepage losses through field border levees were more variable. However, the highest recorded seepage loss was still only 10 cubic meters of water per meter of levee per season (which translates to 5 cm per season for a square 40-ha field). Results from the complete water balances generally corroborated the low seepage and percolation rates seen in the direct measurements, although we were unable to account for 8% of the water on average. Percolation accounted for 0.8 – 2.5% of the applied water based on direct measurements and seepage accounted for 0.9 – 1.8% of the applied water. To our knowledge, the results presented here represent the first direct measurement of seepage and percolation in California rice fields. Our ongoing work seeks to understand the factors influencing these subsurface water losses.