MOISTURE DYNAMICS OF AEROBIC RICE UNDER DIFFERENT IRRIGATION AND GROUND COVER TECHNIQUES

MHJP Gunarathna, [1*], AN Espino Jr.[2] and RM Lampayan[3]

[1]Dept. of Soil & Water Resources Management, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura.

[2]Dept. of Agricultural Engineering, College of Engineering, Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines.

[3]Crop and Environmental Science Division, International Rice Research Institute, Los Banos, Laguna, Philippines.

*Janaka78@rjt.ac.lk,

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INTRODUCTION

Water is becoming a scarce resource in most parts of the world including Asia due to water quality deterioration and increasing population. The amount of water available for irrigation faces competition from industrial and domestic uses and the demand from these sectors will continue to rise. Irrigated agriculture is the biggest consumer of available water in worldwide. In Asia it consumes around 90 % of available water, out of that more than 50 % is used for rice production systems (Barker *et al.*, 1998). In anticipation of a possible water crisis, technology must be developed towards a shift from water consuming continuous anaerobic conditions to water saving aerobic conditions in rice production systems. Aerobic rice production system defined as a rice production system that consists of a combination of specifically developed varieties and well managed agronomic practices (Bouman *et al.* 2007). With shifting from anaerobic to aerobic conditions, some yield penalties may occur due to moisture stress, weeds, pests and diseases. In agriculture, ground covers are used to control weeds, conserve water and improve soil properties (Lin *et al.* 2002).

This study was aimed to assess the moisture dynamics of aerobic rice under different irrigation and ground covers.

METHODOLOGY

A field experiment was conducted at the Water Resources Management Center Research Farm, Central Luzon State University, Science City of Muñoz, Nueva Ecija (15^0 44′ N, 120^0 56′ E) in dry season (January to May) 2009.

Basin irrigation (W_1) and periodic move sprinkler irrigation (W_2) as main plots and bare soil (M_1), rice straw mulching (M_2) and plastic film ground cover (M_3) as sub plots were tested, in a split plot design with four replicates.

After thorough dry land preparation, twenty four sub plots with size of 40 m^2 each were prepared. Each plot was separated by bunds and alleys to control the irrigation water and seepage effects. Seeds of variety PSB Rc-9 (APO) were manually placed along the furrows apart 25 cm each at rate of 60 kg/ha by direct dry seeding. Fertilizer was applied along the furrows at the rate of 100 kg N, 60 kg P_2O_5 and 60 kg K_2O per ha in four splits. Weed control, pest and disease control were practiced when necessary.

Irrigation was done as basin irrigation when soil moisture content reached 22.6% (50% management allowed depletion). A shallow tube well installed near the experimental site was used as source of water. In basin irrigation, irrigation water was conveyed to the plots using 2-inch hose to minimize the conveyance losses. Irrigation was applied until the waterfront reached the longest distance of the plot. In sprinkler irrigation, a locally fabricated periodic move sprinkler irrigation system was used. Sprinkler system was operated for 1.5 minutes per location and 22.5 minutes per plot.

Three ground cover treatments were used in the experiment: 1) bare soil; 2) rice straw; and 3) plastic film. In bare soil treatment, no ground cover was applied to the field. In rice straw treatment, a total of 5000 kg/ha of dry rice straw was spread to the plots as a surface mulch. For the third treatment, commercially available 25-μm plastic film (black) was used.

Data collection

Daily rainfall and daily evaporation were gathered and analyzed. Daily soil moisture content of 0-20 cm depth was measured using HydroSense moisture meter with 20 cm probe rods. Soil water tensions in different treatments were measured daily using soil tensiometers placed at 10 cm depth. The amount of irrigation input was measured using flow meters attached to the pump and flexible hose. Plant parameters (plant height, tiller counts, grain yield and yield components) were measured in the experiment.

All data gathered were analyzed statistically using Statistical Analysis Software (SAS) system for Windows Version 9.1. Comparison among treatment means was done using the Duncan's New Multiple Range Test and a 0.05 probability level was considered for significance.

RESULTS AND DISCUSSION

A dry climate condition was experienced in the month of January to mid April. However, rains started in mid April, which was relatively early compared to normal rainfall pattern in the area. Rainfall of 427.9 mm (91% of total rainfall) was recorded within April 15 to May 24, when the crop was at its reproductive and ripening stages. Average daily pan evaporation was 5.6 mm.

During the vegetative stage of the rice crop, the average soil moisture depletion rates were significantly different in irrigation methods, and ground covers (Table). In vegetative stage where soil was not fully covered by plant canopies, compared to bare soil, moisture was retained 28% longer in the soil when plastic film was used as ground cover and 9% when rice straws were used as ground cover. When the plants developed full canopy, although evaporation losses were reduced, soil moisture depletion rates were increased due to higher transpiration rates. During the reproductive and ripening stages, heavy rains occurred, therefore most of the time soil moisture content maintained closer or above field capacity, except last week of the growing season. Irrigation method or ground covers had no any significant effect on the soil moisture depletion rates at full canopy (Table).

Table 1: Moisture depletion rates, water inputs and grain yield of different treatments

Treatment	Moisture depletion rate during the vegetative stage (mm/day)	Moisture depletion rate during the reproductive and ripening stage (mm/day)	Irrigation water input (mm)	Grain yield at 14% MC (kg/ha)
W_1xM_1	2.90	4.20	504^n	4341
W_1xM_2	2.62	4.40	518^m	4738
W_1xM_3	2.08	4.26	503^n	5067
W_2xM_1	2.65	4.26	239^p	4511
W_2xM_2	2.44	4.28	218^q	4835
W_2xM_3	1.90	4.24	197^r	5058
Avg. W_1	2.54^a	4.28	508^a	4715
Avg. W_2	2.33^b	4.26	218^b	4801
Avg. M_1	2.78^a	4.22	371^d	4426^a
Avg. M_2	2.53^b	4.34	368^d	4786^{ab}
Avg. M_3	1.99^c	4.25	350^e	5062^b

Means in same letters in a same column are not significantly different at 5% level of significance.

Soil moisture tension varied from 8 to 83 kPa during the cropping season, with high readings recorded before irrigations. A day after irrigation, on the average, readings was recorded as 25 kPa and 35 kPa for basin irrigation and sprinkler irrigation respectively. With the occurrence of heavy rains during the latter part of crop growth, soil moisture tension was observed around 20 - 50 kPa in all treatments.

Irrigation water input in sprinkler irrigation was significantly lower than basin irrigation. Plastic film showed significantly lower irrigation water input compared to the rice straw and bare soil (Table). The interaction between plastic film and sprinkler irrigation reported lowest irrigation water input while rice straw and basin irrigation interaction gave the highest. All ground covers combined with sprinkler irrigation were significantly different irrigation water inputs from each other. With basin irrigation, plastic film and bare soil showed significantly lower irrigation water inputs compared to rice straw (Table). Rice straw impeded the flow of irrigation water of basin irrigation, and caused the water to take longer time to reach to longest point of the plots to complete the irrigation.

Irrigation methods showed insignificant differences for all plant parameters. Plastic film showed significantly higher performances for plant height and number of spikelets / panicle compared to bare soil and rice straw. Plastic film shows significantly higher grain yield over bare soil (Table).

CONCLUSIONS

In vegetative phase of rice, sprinkler irrigation can significantly reduce the amount of irrigation without changing the growth parameters or yield of aerobic rice production system.

In vegetative phase of rice, ground covers can significantly reduce the soil moisture depletion rate under aerobic rice production system. Plastic film can significantly increase the grain yield of aerobic rice with significantly lower soil moisture depletion rate compared to bare soil. Rice straw mulching can significantly decrease the soil moisture depletion rate without changing the growth parameters or yield of aerobic rice production system compared to bare soil.

In aerobic rice production system, sprinkler irrigation and plastic film gave the best combination to increase yield with lower irrigation water input.

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