Journal of Medicinal Plants Studies
www.PlantsJournal.com

**ISSN 2320-3862**
JMPS 2015; 3(3): 12-14

Received: 07-03-2015
Accepted: 05-04-2015

**Shiwaji Hembram**
Institute of Agriculture Visva-Bharati Sriniketan-731236, West Bengal, India.

**B.K. Saren**
Institute of Agriculture Visva-Bharati Sriniketan-731236 West Bengal, India.

**Correspondence:**
**Shiwaji Hembram**
Institute of Agriculture Visva-Bharati Sriniketan-731236 West Bengal, India.

# Effect of water regime and plant geometry on growth, yield attributes and water use efficiency of rice (*Oryza sativa L*)

**Shiwaji Hembram, B. K. Saren**

**Abstract**
A field experiment was conducted during *rabi* season of 2013 to find out the effect of water regime and plant geometry on plant height, productivity and water use efficiency on rice *Oryza sativa* L.) The result showed that 4th March transplant rice performed batter in terms of yield, yield attributes characters and water use efficiency with different plant geometry and water regime management practices. The design of the experiment was Split-plot with three replications. Two levels of water management in main plot treatments $W_1$ = Water was applied when soil dries up to hair line cracks and filled up to 3cm and $W_2$ = Water was applied when thin layer of water in the plot and filled up to 3cm height. In sub plot two type of Plant geometry treatment $P_1$ = 20 cm× 20 cm and $P_2$ = 25 cm× 25 cm (plant to plant). With the dose of NPK was 100 kg kg/ha N, 50 kg/ha $P_2O_5$ and 50 kg/ha $K_2O$ respectively applied with basal dose N: $P_2O_5$: $K_2O$ i.e. 40:50:50. The experiment findings revealed that water regime influenced the yield and water use efficiency of the rice crop. Grain yield was found significantly higher under alternate drying and wetting treatment (8%) than that of continuous standing water. Crop geometry does not affect significantly but with spacing of 25 X 25cm (plant to plant) produced higher biological, grain and straw yield and harvest index too over 20x20cm (plant to plant) spacing. Alternate drying and wetting treatment saved 25% water than continuous water stagnation treatment. Among the different treatment combinations water regime (alternate drying and wetting) combined with planting spacing 25x25cm significantly better results in respect of grain yield, biological yield, harvest index, water use efficiency and yields of the crop than other combination of treatment.

**Keywords:** Crop geometry, saturation, significant, water regime, water use efficiency, alternate drying and wetting.

## 1. Introduction
Rice (*Oryza sativa* L.), being the staple food for more than half of the population worldwide (FAO, 2012). It is important cereal crop in West Bangal. Rice is cultivated on an area of 168.4 million hectares with a production of 485.5 million tonnes of milled rice in the world. India has the largest area of about 43.46 million hectares in the world and produce 91.79 million tonnes of milled rice annually (Sridhara *et al.,* 2011) [8]. But the demand of rice increases continuously due to population pressure. It is a major food and mainstay for the rural population and their food security. It is a wage commodity for workers in the cash crop or non-agricultural sectors and plays a major role in national economy of developing countries. Though, India has the largest area under rice in the world, but its productivity level of 2.2 t/ha (Economic survey, 2010) [3] is below the neighboring country, China (>6.0 t/ha) and the average (4.0 t/ha). Rice contributes 43% of total food grain production and 46% of the total cereal production of the country. The main challenge for rice research and development in the world which includes improvement of the small farmers' welfare and rural employment on a sustainable and economic basis is to find ways and means to produce more food for the fast growing population with limited land, less labour, less water and even less chemical inputs as well as to improve. Hence, an experiment was conducted to study the Effect of water regime and plant geometry on yield attributes and water use efficiency of rice (*Oryza sativa* L.) under red and lateritic belt of West Bengal, India.

## 2. Materials and Methods
The field experiment was conducted during summer season of 2013 at the farmer's field a the area is adopted under Visva-Bharati, Sriniketan, Birbhum, West Bangal. The geographical location of Sriniketan is about $20^0$39/N latitude and $87^0$42/E longitude with an average altitude

Of 58.9 meters above MSL. The farmer's field is located in sub-humid, subtropical belt in Western part of West Bengal, having loamy sand soil(pH 6.2, Organic carbon 0.50%, Available N, $P_2O_5$ and $K_2O$ are 191.40,13.40 and 175.90 kg/ha respectively). IR-36 variety of rice was used in the experiment. The experiment was laid out in Split Plot Design (SPD) having three replications of two main plot treatment W1(alternate drying and wetting water upto saturation), W2( 3cm standing water) and six sub plot treatment viz. $P_1S_1$ : 20 cm X 20 cm + 1 seedling, $P_1S_2$ : 20 cm X 20 cm + 2 seedling, $P_1S_3$ : 20 cm X 20 cm + 3 seedling, $P_2S_1$ : 25 cm X 25 cm + 1 seedling,$P_2S_2$ : 25 cm X 25 cm + 2 seedling and $P_2S_3$ : 25 cm X 25 cm + 3 seedling. The crop was transplanted on 4th March and harvested on 4th June 2013 respectively. With general fertilizer of recommend N:$P_2O_5$:$K_2O$ i.e. 100:50:50 with basal dose N:$P_2O_5$: $K_2O$ i.e. 40:50:50. There were 12-treatment combinations and three replications giving a total of thirty-six unit plots each measuring 3m x 2.5m. The experiment findings revealed that water regime influenced growth attributes such as plant height, tiller number, dry matter accumulation, crop growth rate (CGR)and yield attributes like effective tillers per hill, panicle length, grains per panicle, filled grains per panicle and test weight. Harvest index (HI), consumptive use (CU) and consumptive use efficiency (CUE) were also worked out by using standard formulae. Finally collected data were statistically analyzed as per procedures.

## 3. Results and Discussions

### 3.1 Growth parameters

From the experiment findings it is quite evident that alternate drying and wetting treatment significantly influenced growth parameter of summer rice such as plant height, dry matter accumulation, leaf are index and dry matter production. The height of plant, dry matter accumulation and LAI was significantly higher under alternate drying and wetting treatment than that of 3 cm continuous standing water treatment. Crop growth rate was found maximum at 50-70 DAS and the effect was found not significant except 30-50 and 70-90 DAS. Crop geometry also affected the growth attributes, yield attributes, yields, water use and water use efficiency of summer rice. It was observed that wider planting spacing of 25 X 25 cm showed better result than closer spacing of 20 X 20 cm. Planting spacing of 25 X 25 cm recorded higher tiller number per hill, crop growth rate but lower plant height than 20 X 20 cm. Seedling number per hill also influenced the growth and yield attributes yields and water use efficiency markedly. One seedling per hill showed better performance for producing plant height, dry matter production, leaf area index than two or three seedling per hill. Similar result was also reported by Damodaran (2012) [2]. The interaction effect does not found between the main plot and subplot treatment. The lowest biological yield, grain yield, straw yield and harvest index was observed at planting of three seedlings per hill. The crop used water for its growth and productivity was found highest under single seedling planting system.

### 3.2 Yields

After harvesting of the crop, dried properly and weighed plot wise and analyzed statistically which are presented in the table. Biological yield of the crop was affected by the water regime treatment markedly. Alternate drying and wetting (saturation) treatment harvested higher biological yield than continuous standing water treatment yield attributes significantly but grain yield was found significantly higher under alternate drying and wetting treatment (8%) than that of continuous standing water. As all the growth parameters were found lower at standing water treatment, hence, biological yield was also lower than saturation. These results are in conformity with the findings of Belder *et al*. (2005) [1].

Planting of single seedling per hill recorded higher yield parameters caused higher grain yield. On the other hand three seedlings per hill showed the lowest grain yield of crop though the effect was found significant. One seedling per hill produced more grain yield as comparison with three seedling per hill. The result corroborates the finding of Obulamma and Reddeppa (2002) [7]. The interaction effect of the treatments was not significant.

**Table 1:** Effect of water regime, plant geometry and seedling number on plant height, tiller number and LAI of rice plant

| Plant height(cm) at different days after transplanting | | | | | Number on tiller number/ hill different days after transplanting | | | | LAI at different DAT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Treatments** | **30 DAT** | **50 DAT** | **70 DAT** | **90 DAT** | **30 DAT** | **50 DAT** | **70 DAT** | **90 DAT** | **30 DAT** | **50 DAT** | **70DAT** | **90 DAT** |
| **Water regime** | | | | | | | | | | | | |
| W1 | 41.73 | 73.45 | 76.32 | 84.42 | 18.23 | 24.3 | 28.2 | 24.11 | 0.97 | 3.45 | 4.01 | 1.8 |
| W2 | 40.97 | 72.06 | 75.92 | 82.43 | 17.54 | 23.9 | 27.8 | 23.61 | 0.94 | 3.17 | 3.61 | 1.59 |
| **SEm (±)** | 0.53 | 1.17 | 0.05 | 0.25 | 0.41 | 0.46 | 0.05 | 0.65 | 0.01 | 0.07 | 0.05 | 0.01 |
| **CD(P=0.05)** | NS | NS | 0.31 | 1.57 | NS | NS | 0.314 | NS | NS | NS | 0.31 | 0.09 |
| **Plant geometry** | | | | | | | | | | | | |
| P1 (20X20) | 41.07 | 72.74 | 76.08 | 83.24 | 17.63 | 23.96 | 27.96 | 23.71 | 0.94 | 3.25 | 3.77 | 1.63 |
| P2 (25X25) | 41.93 | 72.77 | 76.16 | 83.61 | 18.14 | 24.25 | 28.04 | 24.02 | 0.97 | 3.37 | 3.85 | 1.77 |
| **SEm (±)** | 0.49 | 0.72 | 0.11 | 0.59 | 0.53 | 0.6 | 0.11 | 0.53 | 0.01 | 0.14 | 0.11 | 0.06 |
| **CD(P=0.05)** | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **No. of seedling** | | | | | | | | | | | | |
| S1 | 21.24 | 25.11 | 76.51 | 85.35 | 19.07 | 24.77 | 28.39 | 24.88 | 1 | 3.68 | 4.2 | 2.13 |
| S2 | 20.67 | 72.73 | 76.14 | 83.51 | 17.87 | 23.95 | 28.02 | 23.76 | 0.95 | 3.17 | 3.82 | 1.61 |
| S3 | 20.11 | 70.42 | 75.72 | 81.42 | 16.72 | 23.59 | 27.6 | 22.95 | 0.9 | 3.07 | 3.41 | 1.36 |
| SEm( ±) | 0.6 | 0.89 | 0.14 | 0.72 | 0.65 | 0.69 | 0.144 | 0.65 | 0.01 | 0.18 | 0.14 | 0.08 |
| **CD(P=0.05)** | NS | 2.62 | 0.42 | 2.13 | NS | NS | 0.42 | NS | 0.05 | NS | 0.42 | 0.23 |

**$W_1$=** alternate drying and wetting Water was applied when soil dries up to hair line cracks, **$W_2$**=3cm standing water, **$P_1$**= plant spacing 20X20 cm, **$P_2$**= plant spacing 25X25cm, **$S_1$**=single seedling/hill, **$S_2$** =Two seedling/hill, **$S_3$**= Three seedling/hill.

### 3.3 Water use and Water use efficiency

Total water included rainfall and irrigation water used in producing summer rice was estimated and presented in the table. Water regime affected the total water used in producing the crop markedly. The highest amount of total water was used by the crop at continuous standing water and it was recorded lowest under alternate drying and wetting treatment. Alternate drying and wetting condition reduced the number of irrigation as irrigation was applied when hairline cracks developed in the plots of this treatment and therefore it saved 25% of water as compared with continuous standing water treatment. The results was in the similar line of experiment by show (2007) that alternate drying and wetting conduction helped in increasing water use and water efficiency. Plant geometry of 25x25 cm recorded higher water use efficiency than that of 20x20 cm planting spacing. Wider spacing facilitated to evaporate more water from field and hence water used by the crop was found also higher than closer spacing of 20 x 20 cm. Similarly three seedlings per hill recorded the lowest water use and one seedling per hill recorded highest water use. Three seedlings per hill cover the land area much more than one seedling per hill resulted in lower water use in this treatment than one seedling per hill. Water regime showed significant effect on water use efficiency on summer rice. The highest water use efficiency (42.33 kg/ha-cm) was recorded under alternate drying and wetting condition which was significantly greater than that of continuous standing water treatment. Higher yield of grain with lower water use at saturation caused higher water use efficiency in comparison to continuous water stagnation treatment. Plant geometry also influenced the water use efficiency greatly though the effect was not significant. However, wider spacing of 25x25 cm recorded higher water use efficiency as compared to closer spacing of 20x20 cm. Water use efficiency was also greatly influenced by number of seedling per hill but effect was found not significant. The highest water use efficiency was observed at one seedling per hill followed by two seedlings per hill. Due to low yield as compared with water used, three seedlings per hill recorded the lowest water use efficiency. From the summarized experimental results it is concluded that application of water up to saturation by alternate drying and wetting method with 25x25cm planting spacing using single seedling per hill are congenial for improving growth and productivity of summer rice under SRI technique.

**Table 2:** Effect of water regime, plant geometry and seedling number on yield attributes of rice

| Treatment | Biological yield (t/ha) | Grain yield (t/ha) | Straw yield (t/ha) | H I(%) | Effective tiller/$m^2$ | Panicle Length(cm) | Total no of grain/panicle | No of filled grain/panicle | Test Weight (1000)g | Water use efficiency(kg/ha-cm) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Water regime** | | | | | | | | | | |
| W1 | 13.75 | 5.4 | 7.89 | 39.17 | 275.93 | 19.02 | 101.79 | 87.55 | 22.13 | 42.33 |
| W2 | 13.03 | 4.98 | 7.71 | 38.16 | 268.75 | 18.39 | 99.53 | 84.14 | 21.91 | 31.62 |
| SEm (±) | 0.09 | 0.05 | 0.08 | 0.13 | 0.93 | 0.06 | 0.29 | 0.45 | 0.17 | 0.71 |
| CD(P=0.05) | 0.56 | 0.33 | NS | 0.08 | 5.66 | 0.4 | 1.78 | 2.77 | NS | 4.34 |
| **Plant geometry** | | | | | | | | | | |
| P1 (20X20) | 13.32 | 5.16 | 7.68 | 38.65 | 271.69 | 18.5 | 100.45 | 85.23 | 22 | 36.75 |
| P2 (25X25) | 13.45 | 5.22 | 7.92 | 38.68 | 273.03 | 18.9 | 100.87 | 86.46 | 22.04 | 37.20 |
| SEm(±) | 0.21 | 0.12 | 0.09 | 0.31 | 2.12 | 0.22 | 0.66 | 1.73 | 0.13 | 0.80 |
| CD(P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **No. of seedling/hill** | | | | | | | | | | |
| S1 | 14.08 | 5.56 | 8.15 | 39.47 | 279.26 | 19.54 | 100.84 | 90.96 | 22.29 | 20.00 |
| S2 | 13.42 | 5.22 | 7.74 | 38.86 | 272.64 | 18.6 | 100.75 | 85.76 | 21.94 | 18.26 |
| S3 | 12.67 | 4.78 | 7.51 | 37.67 | 265.14 | 17.96 | 98.39 | 80.82 | 21.82 | 16.86 |
| SEm(±) | 0.26 | 0.14 | 0.11 | 0.38 | 2.6 | 0.27 | 0.81 | 1.68 | 0.17 | 0.98 |
| CD (P=0.05) | 0.76 | 0.43 | 0.33 | 1.13 | 7.67 | 0.8 | 2.41 | 4.96 | NS | 2.91 |

**$W_1$=** alternate drying and wetting Water was applied when soil dries up to hair line cracks, **$W_2$**=3cm standing water, **$P_1$**= plant spacing 20X20cm, **$P_2$**= plant spacing 25X25cm, **$S_1$**=single seedling/hill, **$S_2$** =Two seedling/hill, **$S_3$**= Three seedling/hill.

### 4. References


1. Belder P, Spiertz JHJ, Bouman BAM, Lu G, Tuong TP. Comparative study of water management in two irrigation systems and its effect on the electric conductivity of soil saturation extract and rice (Oryza sativa L.) yield. Field-Crops-Research 2005; 93(2/3):169-185.
2. Damodaran V, Saren BK, Ravisankar N, Bommayasamy, N. Influence of time of planting, spacing, seedling number and nitrogen management practices on productivity, profitability and energetics of rice (*Oryza sativa*) in island ecosystem. Madras Agricultural Journal 2012; 99(7/9):538-544.
3. Economic Survey. Economic survey, Government of India. Minister of Finance. Department of economic affairs. Economic Division. February 2010. Oxford University Press New Delhi, 2010, A19.
4. FAO. Food and Agricultural Organisation, 2011. Rome Italy. http: // faostat.fao.org/site
5. Hussain AM, Chowhan PB, Uddin AFM. Rahman ABM. Final evaluation on report on verification and refinement of the system of rice intensification (SRI) project in selected area of Bangladesh. PETRRA-Project, IRRI, Dhaka, Bangladesh, 2004.
6. Namara RE, Weligamage P, Barker R, Prospectus for Adopting System of Rice Intensification in Sri Lanka: A Socio-economic Assessment research Report 75. International Water Management Institute, Colombo, Sri Lanka, 2003.
7. Obulamma U, Reddeppa R. Effect of spacing and seedling number on growth and yield of hybrid rice. Journal of Res ANGRAU 2002; 30(1):76-78.
8. Sridhara CJ, Ramachandrappa BK, Nanjappa HV, Mavarkar NS. Effect of genotypes, planning geometry and methods of establishment on growth and yield of aerobic rice. Mysore Journal of Agricultural Sciences 2011; 45(3):501-505.