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Article · November 2018

5 authors, including:

Sathyamoorthy NK
Tamil Nadu Agricultural University

P. Prakash
Tamil Nadu Agricultural University

Research Paper

Research Journal of Agricultural Sciences
9(5): 1055-1058, September-October (2018)
ISSN: 0976-1675 https:// www.rjas.org DI: 5167-0306-2018-237

Performance of Selected Rice Varieties/Cultures on Different Irrigation Regimes and Crop Geometry under Aerobic Condition

N K Sathyamoorthy, *A Gurusamy, T Ragavan, J Prabhaharan and P Prakash
Agricultural College and Research Institute, Madurai - 625 104, Tamil Nadu, India
*Agricultural College and Research Institute, Kudumiyanmalai - 622 104, Tamil Nadu, India
e-mail: prakasharivu.tnau@gmail.com

Received: 03 June 2018; Revised accepted: 24 August 2018

ABSTRACT

Furrow irrigated raised bed system being proposed for aerobic rice to increase productivity and to save water. Objective of the study were influence of the irrigation regimes and crop geometry on production performance of rice varieties/culture under aerobic condition. Keeping this as view, A field experiment was conducted at Agriculture College and Research Institute, Madurai, TNAU during 2014 and 2015 two consecutive years. The experiment was laid out in split split plot design with three factors viz. furrow irrigated raised bed system with three different levels of irrigation and crop geometry which is tested with six different varieties/cultures. The growth attributes viz. LAI and DMP at flowering stage and yield attributes (number of panicles and number of filled grains panicle^{-1}), grain and straw yield were calculated. In both the years, among the different treatment combinations, the variety MAS IWM Saltol (V_6) irrigated once in four days with close spacing of 20 x 10 cm ($I_1G_1V_6$) recorded significantly higher LAI compared to other combinations. The variety APO_1 (V_2) irrigated once in four days with close spacing of 20 x 10 cm recorded significantly higher DMP. Among the treatment combinations, $I_1G_1V_6$ was recorded significantly higher number of panicles/m^2 and number of filled grains panicle^{-1}compared to other treatment combinations. The highest grain and straw yield were recorded, variety APO1 grown in spacing of 20 x 10 cm and irrigated once in four days ($I_1G_1V_2$) which is on par with $I_1G_1V_6$.

Key words: Aerobic rice, Dry matter, Irrigation, Varieties, Yield

Rice (*Oryza sativa* L) is the most important food grain consumed by the around 80 per cent of the world population. Nowadays, developing water saving technology with using appropriate varieties makes hot topic in worldwide. One of the major constraints in rice production is availability of water, the production has decreased due to lesser availability of water. Hence the water saving irrigation in rice cultivation getting importance, the ware saving irrigation technologies includes alternate wetting and drying, furrow irrigated raised bed system of rice cultivation, System of rice intensification and aerobic rice cultivation. Aerobic rice is a system of production with unpuddled cultivation using less amount of water. Aerobic rice system provides half of the production than the flooded condition. Maintaining the moisture near the root zone is major problem in aerobic condition, irrigation is given to bring the soil to field capacity after it has reached a lower threshold, often 50% available soil moisture. Establishment method of furrow irrigated raised bed system maintains adequate amount of soil moisture which increase the availability of water to the crops. India and china is the leading rice producers in the world. But unfortunately the countries have higher population in the world which cause major problem in the food security. In this situation to importance of aerobic rice has escalated, production area need to increase that countries. Crop geometry decides the population, higher productivity has achieved by adopting adequate population. In determinate population, makes competitive interactions between the crops. Among the water saving technologies the aerobic rice cultivation saves more water for rice production but under drip irrigation water got saturated in the root zone throughout the cropping period. Hence it improves water use efficiency and water productivity of rice. The soil is not saturated as under lowland system and rice roots grow in an aerobic environment similar to crops like maize or sorghum.

MATERIALS AND METHODS

The field investigation was carried at experiment was conducted at *kharif* season of 2014 and 2015 at Agricultural College and Research Institute, Madurai, TNAU, Tamil Nadu. The experimental site is situated at 9°54' N latitude and 78°54' 'E' longitude and at an altitude of 147 m above mean sea level. The soil of the experimental field was clay loam in texture, taxonomically classified as TypicUdicHaplustalf. The soil of the experimental field was low in available N (210 kg ha^{-1}), medium in available P (17 kg ha^{-1}) and K (280 kg ha^{-1}) status and neutral in reaction.

The experiment was laid out in split split plot design with three replications, the main plot consist of surface irrigation with 4, 5 and 6 days intervals, crop geometry of 20 × 10, 20 × 15 and 20 × 20 cm spacing were assigned in sup plot and the sub sub plot consist of varieties viz. Anna 4, APO 1, Improved White Ponni, CBMAS 14142, CBMAS 14065 and CBMAS Saltol. Raised beds with 90 cm top bed width and 30 cm furrows width were formed and the seeds were sown on raised beds. The lifesaving irrigation of 5 cm depth was given after the sowing of seed, thereafter the irrigation was given as per the treatment of irrigation intervals with 5 cm depth. Recommended dose of nitrogen (150 kg ha^{-1}) as Urea, phosphorus (50 kg ha^{-1}) as Single super phosphate and potassium (50 kg ha^{-1}) as Muriate of potash were applied. The growth parameters (leaf area index and dry matter production), yield parameters (No of panicles and no of filled grains) and yield of grain and straw were measured after harvest of the crop.

Statistical analysis

The data recorded on various parameters recorded during the course of investigation was statistically analyzed as per the procedures suggested by Gomez and Gomez (2010) for split split plot design. Wherever, statistical significance were observed, critical difference (CD) at 0.05 level of probability was worked out for comparison.

RESULTS AND DISCUSSION

Growth parameters

Leaf area index

In both the years of study, among the irrigation regimes, irrigation once in four days (I_1) recorded significantly higher (4.56, 4.99) LAI followed by irrigation once in five days (I_2) (Table 1). Irrigation once in six days (I_3) recorded significantly lower LAI (3.61, 4.25). With respect to plant geometry, closer spacing of 20 × 10 cm (G_1) recorded significantly higher LAI and significantly lower values were obtained in wider spacing 20 × 20 cm (G_3). The varieties have significant influence on LAI. The highest LAI was observed in CB MAS IWM Saltol (V_6) which was on par with APO 1 and (V_5) and CBMAS 14065 (V_5). Among the different combinations, the variety MAS IWM Saltol (V_6) irrigated once in four days with close spacing of 20 × 10 cm ($I_1G_1V_6$) recorded significantly higher LAI compared to other combinations.

It is because in this treatment moreplant height and tiller number resulted in greater LAI at flowering stage. The reduction in LAI with increasing irrigation interval might be due to reduced turgor pressure under moisture stress conditions which affected the leaf cell expansion. Similar observations were also made by Nguyen *et al.* (2009), Bouman *et al*. (2005). With respect to crop geometry wider spacing resulted lower LAI, hence planting at optimum spacing is favourable for the leaf area development. Sritharan and Vijayalakshmi (2012) mentioned that LAI was directly related to grain yield. Therefore, maintenance of high LAI at reproduction stage is desirable for producing high yield in stressed plants.

Dry matter production

The dry matter production (DMP) was significantly influenced by the treatments in both the years (Table 1). With respect to irrigation regimes, irrigation once in four days (I_1) recorded significant higher DMP followed by irrigation once in four days (I_2). Irrigation once in five days (I_3) recorded significantly lower DMP. With regard to plant geometry, closer spacing of 20 × 10 cm (G_1) recorded significantly higher DMP and significantly lower values were obtained in wider spacing 20 × 20 cm (G_3). Among the varieties screened, the variety APO $_1$ (V_2) recorded higher DMP and this treatment on par with CB MAS IWM Saltol (V_6). The lower DMP was observed with and (V_3). Among the different combinations, the variety APO_1 (V_2) irrigated once in four days with close spacing of 20 × 10 cm recorded significantly higher DMP and this treatment was on par with $I_1G_1V_6$.

The highest dry matter accumulation with irrigation scheduled at once in four days might be attributed to the fact that increased frequency of irrigations in the above schedule has facilitated higher water and nutrient uptake applied to the crop coupled with possible reduction in transpiration rate and CO_2 exchange resulted in increased production of photosynthates and their translocation to sink (Shekara and Sharanappa 2010). Similar findings were also reported by Kato *et al.* (2006). Studies of Ockerby and Fukai (2001) also showed that higher dry matter production in aerobic rice varieties during the crop growth period might be due to increased number of tillers and leaf area index. Lowest amount of dry matter production observed in all the stages of plant with irrigation scheduled at irrigation at once in six days. Experiment results of Ghosh *et al.* (2010), Maheswari *et al.* (2007), Belder *et al.* (2005) reveal that lower dry matter production in irrigation scheduled at six days interval might be due to reduction in cell division, cell volume, cell elongation, photosynthesis and biomass production which occurs under higher moisture stress conditions. With respect to spacing 20 × 10 recorded higher DMP compared to others treatment; this might be due to this treatment recorded higher leaf area index which favours the higher light interception. The amount light interception increases the photosynthesis which in turn increases the photosynthates, it may the reason for higher dry matter production.

Yield parameters

The number of panicles was significantly influenced by treatments in a both the years of study (Table 1). Irrigation once in 4 days resulted in higher number of panicles and significantly lower number of panicles was observed in I_3 (Irrigation once in five days). The closer spacing of 20 × 10 cm, significantly increased the number of panicles/m^2

followed by 20 × 15 cm spacing (G_2). Among the varieties, CB MAS IWP saltol recorded significantly higher values and this treatment on par with V_5. Among the treatment combinations, $I_1G_1V_6$ was recorded significantly higher number of panicles/m^2 compared to other treatment combinations. Ramamoorthy *et al.* (1998) also indicated that increased yield attributes might be due to higher dry matter production as a result of frequent irrigations. The lowest number of panicles m^{-2} was associated with irrigation scheduled at once in six days. It might be due to lower number of tillers m^{-2} and dry matter production. These results are conformity with the Maheswari *et al.* (2007). Regarding to varieties under aerobic condition, all varieties grew rapidly at tillering stage then slow growth at reproduction stage until harvest. According to Kamoshita and Abe (2007), tiller number subsequently increase the both source and sink capacity. Rice grain yields are highly dependent upon the number of panicle produced per plant. These results are in accordance to the observations of Hasamuzzaman *et al.* (2009).

Table 1 LAI (flowering), DMP (harvest) and number of panicles m^{-2} and the number of filled grains per panicles of aerobic rice varieties influenced by irrigation regimes and plant geometry

Treatment	LAI		DMP		No. of panicles / m^2		No of filled grains $panicle^{-1}$	
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year
Irrigation regimes								
I_1: Irrigation once in four days	4.56	4.99	6776	7702	398	458	170	186
I_2: Irrigation once in five days	4.06	4.58	6075	6970	354	424	154	176
I_3: Irrigation once in six days	3.61	4.25	5457	6296	315	385	136	163
SEd	0.03	0.02	25.7	32.27	4.2	1.81	2.9	0.7
CD(P=0.05)	0.09	0.06	69.48	89.59	11.7	5.02	8.0	1.95
Plant geometry								
G_1: 20 × 10 cm	4.7	5.2	6757	8040	413	470	176.3	197
G_2: 20 × 15 cm	3.9	4.5	5934	6958	347	404	148.0	172
G_3: 20 × 20 cm	3.5	4.2	5210	6286	307	376	131.3	155
SEd	0.03	0.02	5.3	43.43	4.7	2.38	2.6	1.01
CD(P=0.05)	0.07	0.06	11.4	94.63	10.2	5.18	6.2	2.21
Varieties								
V_1: Anna 4	3.7	4.13	5452	6175	320	389	137.0	161
V_2: Apo 1	4.6	5.22	6975	8157	380	460	177.3	189
V_3: Improved White Ponni	3.1	3.53	4638	5274	273	323	116.7	139
V_4: CB MAS 14 142	3.9	4.43	5895	6776	344	414	147.7	169
V_5: CB MAS 14 065	4.5	5.11	6743	7858	394	472	167.7	192
V_6: CB MAS IWP saltol	4.6	5.23	6911	7927	419	475	174.7	199
SEd	0.09	0.09	94.7	148.08	11.7	8.91	6.5	3.69
CD (P=0.05)	0.18	0.19	188.1	294.19	23.3	17.69	13	7.33

The number of filled grains/panicles was significantly influenced by irrigation treatments. Irrigation once in 4 days resulted in higher number of filled grains compared to other irrigation regimes. Among the plant geometry, the closer spacing of 20 × 10 cm, significantly increased the number of filled grains/panicle (186.9) followed by 20 × 15 cm spacing (G_2). With regarding to varieties, CB MAS IWP saltol recorded significantly higher values of 187 and this treatment on par with V_5. Among the treatment combinations, $I_1G_1V_6$ was recorded significantly higher number of panicles/m^2 compared to other treatment combinations. It's because of increased number of irrigations leads to more amounts of water availability plants and that leads to increased photosynthates accumulation (Shekara *et al.* 2010). The lowest number of filled grains $panicle^{-1}$ obtained for irrigation schedule at once in six days intervals. This was might be due to at lowest soil water condition, low availability of nutrients and low photosynthates accumulation and finally leads to more chaffed grains (Sudhir *et al.* 2011).

Grain and straw yield

Among the irrigation regimes, irrigation once in four days (I_1) recorded higher grain yield compared to other irrigation regimes in both the years (Fig 1). Among the plant geometry, closer spacing of 20 × 10 cm (G_1) registered significantly higher grain yield and wider spacing of 20 × 20 cm (G_3) recorded lower grain yield. The bold grain variety (APO1) registered higher grain yield 3266 kg/ha followed by CB MAS saltol (V_6) with grain yield of 3169 kg/ha. Among the treatment combinations, variety APO1 grown in spacing of 20 × 10 cm and irrigated once in four days ($I_1G_1V_2$) has recorded higher grain yield, which is on par with $I_1G_1V_6$. These findings were in agreement with results of Gupta *et al.* (2003). And also, the higher grain yield was might be due to increase in yield attributing characters viz. panicles m^{-2}, grain $panicle^{-1}$ and number of filled grains $panicle^{-1}$ was observed under high soil moisture regime as a result of frequent irrigation (Shekara *et al.* 2010). Lowest grain yield was obtained in irrigation scheduled at once in six days interval. The yield reduction observed with irrigation scheduled at once in six days interval might be due to reduced tillers m^{-2}, panicle number m^{-2} and low dry matter production as evidenced in the above treatments as a result of less frequent irrigations resulting in moisture stress and low nutrient uptake during the crop growth period (Sudhir *et al.* 2011).

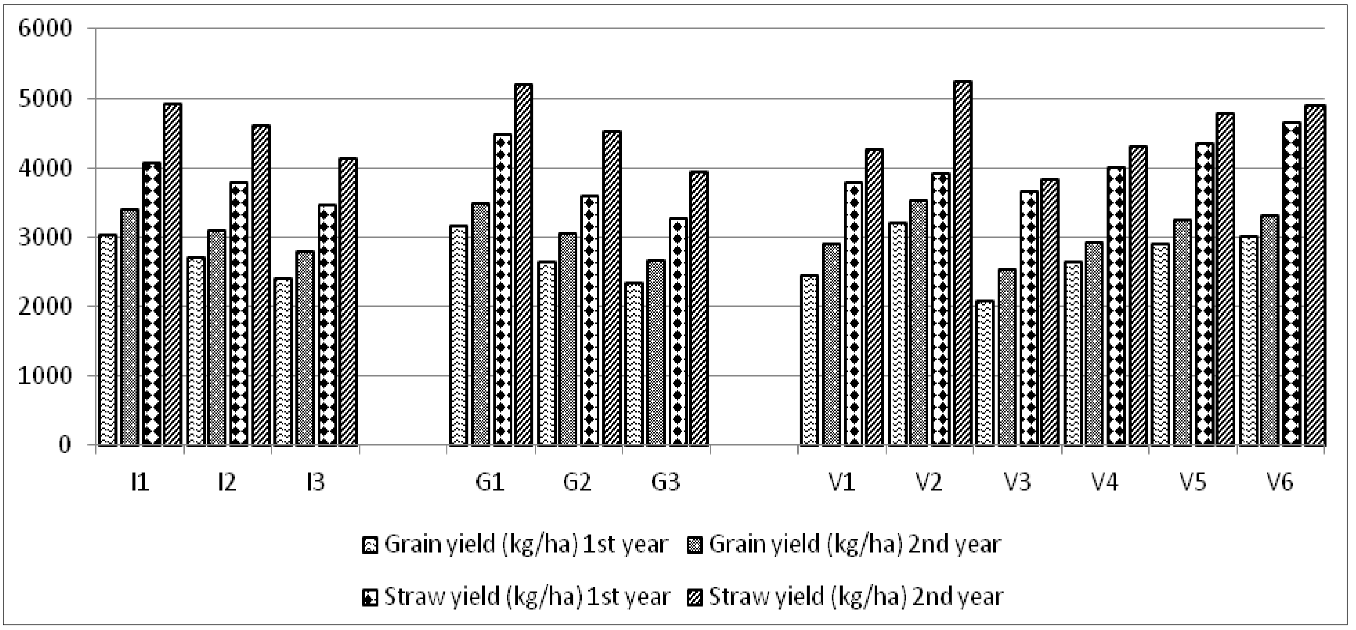

Fig 1 Grain and straw yield of aerobic rice varieties influenced by irrigation regimes and plant geometry

In conclusion, the results prove that irrigation regimes and crop geometry highly influence the different rice varieties/culture. From the study knows that variety suitable for aerobic rice cultivation. Irrigation the crop with once in four days, retain more moisture in the soil which increase the availability of water to the crop in turn which increase the growth and yield. Further investigation are needed on the effect of irrigation regimes on soil water distribution and nutrient uptake thus couple with physiology of a plant for better management practice in cultivating rice varieties under aerobic condition.

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