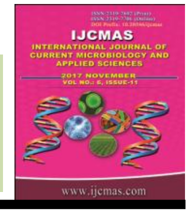
Int.J.Curr.Microbiol.App.Sci (2017) *6*(11): 4100-4108

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 11 (2017) pp. 4100-4108**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2017.611.480

Influence of Rice Varieties and Irrigation Regimes on Rice under Raised Bed and Drip Fertigation

Sathiyaraj*

Agricultural Officer, Department of Agriculture, Tamil Nadu, Poraimedu, Settiyur (Post), Mettur (Taluk), Salem District-636303, Tamil Nadu, India
**Corresponding author*

Keywords

RB-Raised Bed, BW-Bed width, DI -Drip Irrigation and SRI-System Rice Intensification.

Article Info

Accepted:
28 September 2017
Available Online:
10 November 2017

A B S T R A C T

Field experiment was conducted at Agronomy and ACRIP Research Block, Department of Agronomy, Agricultural College and Research Institute, (Tamil Nadu Agricultural University, Coimbatore) Madurai during kharif season, 2007, to study the influence of rice variety, hybrid, irrigation regimes under raised bed and drip fertigation. The study revealed that growth and yield contributing characters were higher in CO(R)H 3 with raised bed (RB) 120cm bed width (BW) – Maintaining water in furrow and recorded highest grain yield of 6.452 t ha^{-1}. The next best treatment was ASD 16 RB 120 cm BW maintaining water in furrow (5.968 t ha^{-1}) and it was on par with SRI (5.876 t ha^{-}) and drip irrigation with CO(R)H 3 + RB 120 cm BW once in 2 days-100 % PE) (5.847 t ha^{-1}). Increased water was used in ASD 16 with RB 90, 120 cm BW maintaining water in furrow and lesser water used was recorded under CO(R)H 3 with RB 90 cm BW –Drip Irrigation (DI) -100 % PE-daily and Once in 2 days. Higher water saving is recorded under drip irrigation treatments. The highest water use efficiency was recorded in treatment combination CO(R)H 3 RB 120cm BW- DI -100 % PE-Once in 2 days. Interaction effect of CO(R)H 3 with RB120cm BW– Maintaining water in furrow recorded highest gross, net and BC ratio. Overall results of the study indicated that CO(R)H 3 with Raised Bed 120cm Bed Width – Maintaining water in furrow performed better and wherever water scarcity occur better go for The highest water use efficiency was recorded in treatment combination CO(R)H 3 RB 120cm BW- DI -100 % PE-Once in 2 days drip irrigation because water use efficiency and water saving was higher in drip irrigation.

Introduction

Water saving technologies should be required for future growing demand of water, food grain production, population and against industrialization, globalization and urbanization. This research will give appropriate technology for drastically reducing irrigation water. To produce 1 kg of rough (unmilled) rice on an average 2500 mm of water is needed (Bouman, 2009). Subsurface drip irrigation improved mean grain yield reduction of rice from 24.2 per cent as observed with surface irrigation using a limited water supply, to 12.4 per cent besides higher water productivity and nutrient use efficiency (Vanitha, 2011). Borrel *et al.*, (1997) indicated that crop water use of rice grown on raised beds was 32% less when grown using conventional permanent flood. High yielding rice crop have been successfully grown on raised beds and drip irrigation. Potential gains from growing rice on raised beds are considered to be associated with the farming system and include greater flexibility in crops that can be grown in rotation, double cropping and increased water use efficiency of the cropping system.

Drip system with lateral spacing of 0.8 m with 1.0 L h-1 drippers with Subsurface drip irrigation could be recommend for aerobic rice cultivation for the areas with limited water availability (Parthasarathi *et al.*, 2013). The traditional method of rice cultivation consumes around 5000 liters of water to produce one kg of grain, which is three times higher than other cereals. Traditional rice production system leads to wastage of water. It is important that alternative irrigation methods for rice be investigated in the event such changes take place. This study was indicated that drip irrigation reduced irrigation inputs by 80 % compared with conventional flood-irrigation in rice cultivation.

Materials and Methods

Field experiment was conducted at Agronomy and ACRIP Research Block, Department of Agronomy, Agricultural College and Research Institute, Madurai during kharif season, 2007, to study the influence of rice variety and hybrid and irrigation regimes under raised bed and drip fertigation. The farm is situated at an elevation of 147 m above MSL. The latitude is 9^0 54' and longitude 78^0 80'. The soil was neutral in pH and low, medium and high in available N, P and k respectively. The design adopted was factorial randomized block design.

Recommended dose of fertilizer of 150:50:50 and 150:60:60 Kg NPK ha^{-1} were applied for variety and hybrid, respectively. In raised bed system 100 % phosphorus and 50 % of N & K applied as basal and remaining 50 % N & K were applied at 5 equal splits viz. 20, 30, 45, 60 and 80 DAS. Fertigation was given from 10 DAS to flower initiation with equal splits based on the growth stages of crop. N & K were applied through drip as Urea and Potash (MOP) and P as Single Super phosphate for basal application. Irrigation regimes were given according to the treatment details. Irrigation water was given based on the open pan evaporation readings. Effective rainfall was calculated during crop growth period. The raised beds were laid out manually with 90 and 120 cm width, furrow width of 30 and depth of 15 cm and made fine tilth for easy sowing and germination. Seeds were soaked in water for 12 hrs and kept in shade for 10 hrs then seeds were dibbled in lines at a spacing of 20 x 15 cm. The treatments were replicated three time. The 12 mm size of drip laterals with 60 cm dripper to dripper spacing with 4 litre/hour dripper discharge, were installed in raised bed under drip irrigation treatment. Grain and straw yield of variety and hybrid were recorded from net plot area. Plant height, dry matter production, productive tillers, number of filled grains, thousand grain weight, water use, water use efficiency, water saving and economics during the study.

Results and Discussion

Growth parameters

Plant height

The variety ASD 16 recorded higher plant height (119.0 cm) at harvest. When compare to irrigation with different bed width, Raised Bed 120cm Bed Width – Maintaining water in furrows (T_6) on par with Raised Bed 120cm Bed Width-Drip Irrigation-100 % PE-Once in 2 days (T_{10}). Interaction effect of variety, hybrid and spacing levels with irrigation regimes was non-significant. Based on the genotypic characters profuse plant height was recorded in ASD 16. The soil moisture kept above the field capacity by the frequent irrigation (once in three days) and good soil aeration throughout the crop growth period due to the furrow irrigation in raised bed system of cultivation might have favoured the faster cell division and cell elongation which ultimately resulted in higher plant height. The similar findings were earlier reported by Bouman and Tuong (2001).

Dry matter production at milking stage

As indicated Table 1, the rice hybrid CO(R)H 3 recorded higher total dry matter of 65.75 g plant^{-1} at milking stage. The increased total dry matter production was recorded in raised bed 120 cm bed width – Maintaining water in furrows (T_6). The combination of CO(R) H 3 with T_6 recorded higher total dry matter production (71.29 g/plant) and was on par with CO(R) H 3 with T_{10} (70.08 g plant^{-1}). The increase in DMP under raised bed system with maintaining water in furrows might have brought up by loose soil which facilitates more access to water, nutrients by roots which resulted in better plant establishment with higher tiller production. The leaves grew faster with larger area during tillering stage and become thick and erect during full heading stage thereby increased the photosynthetic leaf area. Due to this added advantage of more leaf area and then increased photosynthetic rate the rice crop under raised bed system of cultivation produced more number of productive tillers per unit area with erect, thick stem which ultimately resulted in the production of more biomass compared to SRI and drip irrigated rice. These results were in accordance with the findings of Zhang XiuFu *et al.,* (2005).

Productive tillers at harvest

Among the rice culture, CO(R)H 3 has recorded significantly higher number of tillers. T_6 recorded higher number of tillers. This was on par with T_{10}. Higher numbers of tillers were recorded under the combination of CO(R) H 3 with T_6. This was on par with CO(R) H 3 with T_{10}.

The higher productive tiller production under raised bed was mainly due to better aeration with adequate water and nutrient supply throughout the crop period which favoured more root growth with increased leaf area with better conversion of tiller to productive tillers. This clearly indicated that the productive tillers per hill have been highly influenced by hybrid vigour. This result was in conformity with the findings of Bouman and Tuong (2001).

Yield attributes

Number of filled grains

Hybrid CO(R)H 3 has recorded more number of filled grains. Among the irrigation treatments, T_6 recorded more number of filled grains (86.4). Under combination CO(R)H 3 with T_6 recorded higher number of filled grains (86.4) (Fig 1). This higher number of filled grains per panicle was mostly due to more availability of water, nutrients and aeration for hybrid rice under raised bed system. This result was inline with the finding of Tahir Hussain Awan *et al.,* (2007) in rice.

Thousand grain weight

Increased 1000 grain weight was recorded in the variety ASD 16 (23.32 g) compared to hybrid. Among the subplot treatments, T_6 recorded higher grain weight of 23.84 g.

Interaction effect of ASD 16 with T_8 recorded higher grain weight of 24.36 g. this was mainly due to varietal characters and influenced by drip fertigation and shorter bed with.

Treatment details

Main plot
V_1 – ASD 16
V_2–CO(R)H 3

Subplot
T_1 – Transplanted rice
T_2 – System Rice Intensification (SRI) – 20x20 cm
T_3 – Raised Bed 90 cm Bed Width – Once in 2 days irrigation
T_4 – Raised Bed 120 Bed Width – Once in 2 days irrigation
T_5 – Raised Bed 90 cm Bed Width – Maintaining water in furrows
T_6 – Raised Bed 120cm Bed Width – Maintaining water in furrows

Drip fertigation
T_7 – Raised Bed 90 cm Bed Width – Drip Irrigation – 100% PE - Daily
T_8 – Raised Bed 120cm Bed Width – Drip Irrigation – 100% PE - Daily
T_9 –Raised Bed 90 cm Bed Width –Drip Irrigation-100%PE-Once in 2 days
T_{10}–Raised Bed 120cm Bed Width-Drip Irrigation-100%PE-Once in 2 days

Table.1 Effect of treatments on plant height, total DMP and tiller per plant of rice variety ASD 16 and rice hybrid CO(R) H 3

Treatments	Plant height at harvest (cm)			Total DMP at milking			Tillers per plant (no.)		
	ASD 16	CO (R)H 3	Mean	ASD 16	CO (R)H 3	Mean	ASD 16	CO(R)H 3	Mean
T_1	119.4	99.8	**109.6**	62.6	65.9	**64.2**	13.4	18.5	**16.0**
T_2	112.0	102.5	**107.3**	66.1	61.2	**63.7**	14.1	20.5	**17.3**
T_3	114.6	97.4	**106.0**	62.1	60.5	**61.3**	13.1	18.9	**16.0**
T_4	110.7	94.2	**102.5**	60.5	65.9	**63.2**	12.8	18.4	**15.6**
T_5	119.8	98.7	**109.3**	66.6	68.4	**67.5**	14.6	21.1	**17.9**
T_6	125.6	105.6	**115.6**	67.7	71.3	**69.5**	16.5	22.3	**19.4**
T_7	117.9	101.2	**109.6**	63.3	64.9	**64.1**	14.7	21.3	**18.0**
T_8	118.4	99.8	**109.1**	62.9	65.5	**64.2**	13.9	19.5	**16.7**
T_9	117.5	101.5	**109.5**	62.6	63.9	**63.2**	14.2	20.9	**17.6**
T_{10}	124.5	103.4	**114.0**	63.9	70.1	**67.0**	16.4	22.1	**19.3**
Mean	**119.0**	**100.4**		**63.80**	**65.75**		**14.4**	**20.4**	
	V	T	V x T	V	T	V x T	V	T	V x T
SEd	0.6	1.4	2.0	0.45	0.95	1.35	0.1	0.2	0.3
CD (0.05)	1.3	2.8	Non-significant	0.86	1.93	2.72	0.2	0.5	0.6

Table.2 Combined effect of variety, hybrid and different system of rice cultivation on economic and straw yield of raised bed system of rice cultivation (t ha^{-1})

Treatments	Grain yield (t ha^{-1})			Straw yield (t ha^{-1})		
	ASD 16	CO(R)H 3	Mean	ASD 16	CO(R)H 3	Mean
T_1	5.326	5.647	**5.487**	6.897	6.486	**6.692**
T_2	5.623	5.876	**5.750**	7.345	6.994	**7.170**
T_3	4.514	4.856	**4.685**	5.765	5.368	**5.567**
T_4	4.726	5.210	**4.968**	6.189	5.992	**6.090**
T_5	5.310	5.678	**5.494**	6.452	6.530	**6.491**
T_6	5.968	6.452	**6.210**	7.845	7.351	**7.598**
T_7	4.746	5.215	**4.981**	6.345	5.997	**6.171**
T_8	5.016	5.450	**5.233**	6.648	6.268	**6.458**
T_9	5.156	5.245	**5.201**	6.456	6.032	**6.244**
T_{10}	5.626	5.847	**5.737**	6.740	6.653	**6.696**
Mean	**5.201**	**5.548**		**6.668**	**6.367**	
	V	T	V x T	V	T	V x T
SEd	0.027	0.061	0.087	0.037	0.083	0.117
CD (0.05)	0.056	0.124	0.176	0.075	0.167	0.236

Table.3 Combined effect of variety, hybrid and different system of rice cultivation on total water used, water saving and water use efficiency of aerobic rice

Treatments	**Total Water Used (mm)**			**Water Saving (%)**		**Water Use Efficiency (kg/hamm)**		
	ASD 16	CO(R) H 3	**Mean**	ASD 16	CO(R) H 3	ASD 16	CO(R) H 3	Mean
T_1	693	657	**675**	-	-	7.7	8.6	**8.1**
T_2	693	657	**675**	-	-	8.1	8.9	**8.5**
T_3	538	508	**523**	22	23	8.4	9.6	**9.0**
T_4	538	508	**523**	22	23	8.8	10.3	**9.5**
T_5	652	603	**627**	6	8	8.1	9.4	**8.8**
T_6	652	603	**627**	6	8	9.2	10.7	**9.9**
T_7	529	499	**514**	24	24	9.0	10.4	**9.7**
T_8	532	502	**514**	23	24	9.4	10.9	**10.1**
T_9	529	499	**514**	24	24	9.7	10.5	**10.1**
T_{10}	532	502	**517**	23	24	10.6	11.7	**11.1**
Mean	**589**	**554**				**8.9**	**10.1**	
	V	T	V x T			V	T	V x T
SEd	4.6	10.3	14.5			0.05	0.11	0.16
CD (0.05)	9.3	20.8	29.4			0.10	0.22	0.32

Table.4 Combined effect of variety, hybrid and different system of rice cultivation on Net return and BC ratio of aerobic rice

Treatments	Net return (Rs. ha^{-1})		B:C ratio	
	ASD 16	**Co(R)H 3**	**ASD 16**	**Co(R)H 3**
T_1	34742	41625	3.13	3.34
T_2	37155	44217	3.22	3.50
T_3	25301	31848	2.41	2.67
T_4	27524	35683	2.55	2.87
T_5	32774	40591	2.83	3.12
T_6	39447	48714	3.22	3.55
T_7	24560	32631	2.17	2.47
T_8	27914	35780	2.38	2.66
T_9	28300	32947	2.35	2.48
T_{10}	33445	39923	2.65	2.85

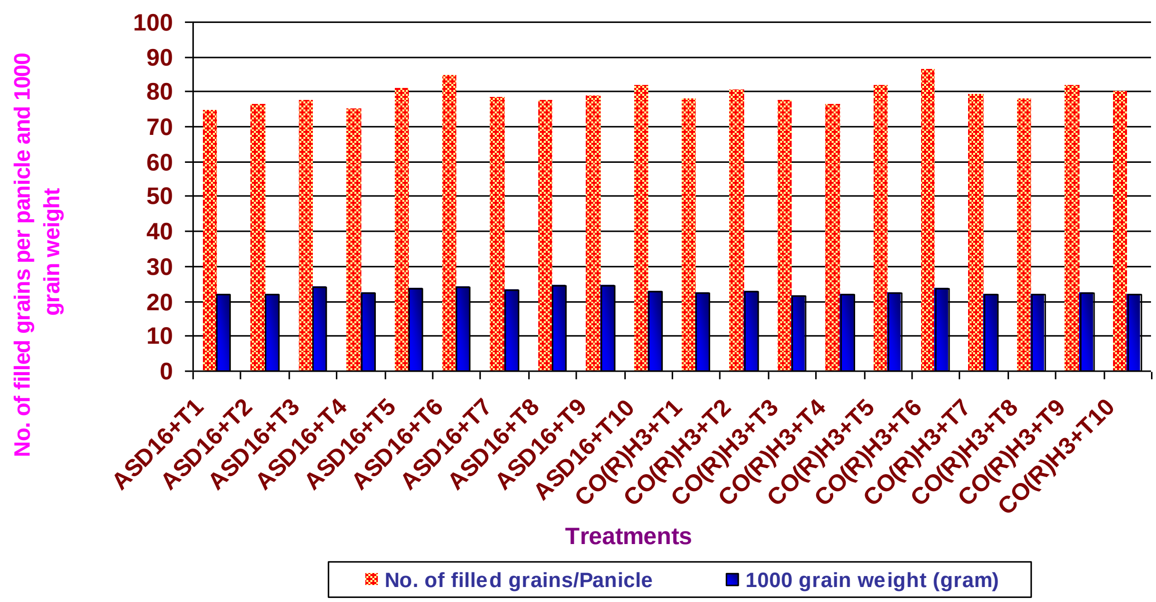


Fig.1. Effect of Treatments on number of filled grains per panicle and 1000 grain weight

Grain and straw yield

The rice hybrid CO(R) H 3 was recorded highest grain yield of 5.548 t ha^{-1} and ASD 16 was observed lowest grain yield of 5.201 t ha^{-1}. The effect of RB 120cm BW maintaining water in furrow was recorded significant grain yield of 6.452 t ha^{-1} and next best was System rice intensification (one day after disappearance if water). However, it was on par with drip irrigation with RB 120 cm BW once in 2 days (100 % PE) (Table 2). The treatment RB 90 cm BW once in 2 days (100 % PE) was recorded lowest grain yield of 4.685 t ha^{-1}. The better and improved performance of crop with higher yield under CO(R)H 3 + RB 120 cm BW maintaining water in furrow was recorded highest grain yield of 6.452 t ha^{-1}. The next best treatment was ASD 16 RB 120 cm BW maintaining water in furrow on par with SRI (one day after disappearance if water) and drip irrigation with Co(R)H 3 + RB 120 cm BW once in 2 days (100% PE) (5.968, 5.876 and 5.847 t ha^{-1}), respectively. This was mainly due to the increased productive tiller production in combination with the higher performance of all yield attributing characters such as dry matter production, number of grains per panicle and filled grains per panicle etc. Further this system of rice cultivation favours increased availability of soil moisture in combination with better soil aeration which in turn favours higher root growth and increased uptake of all plant nutrients by the crop. Similar reports of lower yield with narrow spaced raised beds have also been reported by Borrell *et al.,* (1997). He also indicated that low yields in bed may also be due to differences in nutrient status compared with flooded flats and loss in net cultivable area (15 % less area in bed width of 130 and 30 % less area in bed width of 65 cm) which was occupied by the furrows.

This result clearly indicates that bed width plays a vital role in deciding the rice crop yield inspite of its more coverage of planted area since the distribution of water is not uniform from the edge to the middle of the bed. Further due to continuous stress with the limited availability of soil moisture in the middle portion of the bed leads to poor crop performance and in particular the sterility percentage is very high due to this factor. Ramulu *et al.,* (2016) indicated that Irrigation equivalent to 150% pan evaporation replenishment and nitrogen fertigation at 120 kg N/ha produced significantly higher rice grain yield. Surface drip irrigation scheduling Based on evaporation replenishment factor in aerobic rice realized higher water productivity with considerable water saving over conventional flood irrigated rice. Further, the predicted maximum grain yield levels were at 920 mm of crop ET and 140 kg N/ha among different drip irrigation and N fertigation levels tested. Aerobic rice technology is better remedy for future climate change under drought condition with lesser greenhouse gas emission.

Irrigation and water use

Increased water was used in V_1T_5 and V_1T_6 and lesser water used was recorded under V_2T_7 and V_2T_9. Higher water saving recorded under drip irrigation treatments T_7, T_8, T_9 and T_{10} respectively (Table 3). The highest water use efficiency was recorded in treatment combination V_2T_{10} treatment (11.7 kg/ha m). This was mainly attributed that less water use and continuous availability of water and nutrients that resulted in higher uptake of nutrients in turn production of higher dry matter under drip fertigation (Soman, 2012).

CO(R)H 3 with RB-120cm-BW-Maintaining water in furrow was better performed. Then next best is ASD 16 with RB-20cm-BW and maintaining water in furrow was on par with CO(R)H 3 + SRI and CO(R) H 3 with drip irrigation under RB with 120cm BW-once in 2 days (100 % PE). The Furrow treatment used significantly less water than the ponded treatments and the Drip had significant lower water use than all other treatments. Results indicated that, drip irrigation reduced irrigation inputs by 80 % compared with conventional flood-irrigation. Subsurface drip irrigation appears to be a valid alternative to conventional flood culture based on water savings and yield Ottis *et al.*, (2006).

Christen and Lovejoy (2004) were conducted to investigate Rice was initially irrigated by flooding and then was irrigated via the buried drip tube. Subsurface drip irrigation supplied adequate water to meet the crop water requirements, but the redistribution of water to the edges of the bed was disadvantageous. Drip irrigated rice must be irrigated at a very high frequency (daily) so that the soil may be able to effectively transmit water from the emitter to the root zone. Lovejoy (2003) revealed that edges of the beds were found to dry out considerably, the center of the bed was saturated. As areas of soil dried out it became very difficult to rewet them, because as a soil dries its' hydraulic conductivity reduces. Overall the drip irrigation was able to supply adequate water to meet crop water requirements and redistribution of the water to the edges of the bed was higher. Raised bed planting system of hybrid rice cultivation practice resulted in higher total water saving. In aerobic rice system, wherein the crop is established in non-puddled, non-flooded fields and rice is grown like an upland crop (unsaturated condition) with adequate inputs and supplementary irrigation when rainfall is insufficient. The water productivity of rice under aerobic conditions was 32-88% higher than under flooded conditions (Bouman 2005).

Economics

Among the treatment combinations, CO(R)H 3 with T_7 and T_9 recorded highest cost of cultivation. This was mainly due to bed with was small and required higher length of drip irrigation laterals thereby recorded higher cost. Interaction effect of CO(R)H 3 with T_6 recorded highest gross, net and BC ration of Rs. 67828, 48714 and 3.55 respectively followed by ASD 16 with T_6 in gross and net income and CO(R)H 3 with T_2 in BC ratio (Table 4). Rice cultivation in raised bed required less labour through avoid puddling and nursery preparation and thus resulted in higher net return with increased crop yield.

The field experiment indicated that growth and yield contributing characters were higher in CO(R)H 3 with Raised Bed 120cm Bed Width Maintaining water in furrow and recorded highest grain yield of 6.452 t ha^{-1}. The next best treatment was ASD 16 RB 120 cm BW maintaining water in furrow (5.968 t ha^{-1}) and it was on par with SRI (5.876 t ha^{-1}) and drip irrigation with CO(R)H 3 + RB 120 cm BW once in 2 days-100 % PE) (5.847 t ha^{-1}). Increased water was used in ASD 16 with RB 90, 120 cm BW maintaining water in furrow and lesser water used was recorded under CO(R)H 3 with RB 90 cm BW –Drip Irrigation -100 % PE-daily and Once in 2 days. Higher water saving recorded under drip irrigation treatments. On the basis of data it could be concluded that The highest water use efficiency was recorded in treatment combination CO(R)H 3 RB 120cm BW- Drip Irrigation -100 % PE-Once in 2 days.

References

Bouman BAM, Peng S, Castaneda AR and Visperas RM., 2005. Yield and water use of irrigated tropical aerobic rice systems. Agril. Water Manage. 74: 87-105.

Bouman, B.A.M. and T.P. Tuong., 2001. Field water management to save water and increase its productivity in irrigated lowland rice. Agric. Water Manage., 49: 11-30.F

Bouman, B.A.M., 2009. How much water does rice use. Rice Today.Jan– Mar., 28 – 29.

Christen, E and Lovejoy, S., 2004. Subsurface drip irrigation for rice. Farmers' Newsletter, No. 165: 8-9.

Lovejoy, S., 2003. Subsurface drip irrigation for rice on beds. Summer student report. CSIRO Land and water, Griffith, NSW, 2680.

Ottis, B., Henggeler, J and Vories, E.D., 2006. Low-pressure, subsurface drip-irrigation for rice. ASA-CSSA-SSSA Annual Meeting [abstracts]. November 12-16, Indianapolis, Indiana.

unpaginated CD-ROM.
Parthasarathi, T., S. Mohandass, S. Senthilvel and Eli Vered., 2013. Effect of various micro irrigation treatments on growth and yield response of aerobic rice. December, 2013 International Agricultural Engineering Journal Vol. 22, No. 4 49-62.
Ramulu, V., V. Praveen rao, M.Uma devi, K.Avil kumar and K.Radhika, 2016. Evaluation of drip irrigation and fertigation levels in aerobic rice for higher water productivity 2nd world irrigation forum 6-8 November 2016, Chiang mai, Thailand.
Soman, P., 2012. Drip fertigation for rice cultivation.
Tahir Hussain Awan, Inalyat Ali, M. Ehsan Safdar and Mirza M. Ashraf and Muhammad Yaqub., 2007. Economic effect of different plant establishment techniques on rice, Oryzia sativa, Production. Journals of Agricultural Research, 45 (1): pp.73- 80.
Zhang XiuFu, Wang DanYing, Qu YanYan and Li Hua., 2005. Morphological and physiological characteristics of raised bed-cultivated rice. Acta Agronomica Sinica, 31 (6): Pp. 742-748.

How to cite this article:

Sathiyaraj. 2017. Influence of Rice Varieties and Irrigation Regimes on Rice under Raised Bed and Drip Fertigation. *Int.J.Curr.Microbiol.App.Sci.* 6(11): 4100-4108.
doi: https://doi.org/10.20546/ijcmas.2017.611.480