

Original Research Article

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Investigation on Field Water Tube and Low Dose Herbicides on Growth Parameters, Microbial Population and Yield of Transplanted Rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted at Agricultural College and Research Institute, Killikulam during early *Pishanam* season of 2018-2019 to investigating suitable irrigation practices through field water tube and weed management practices through low dose herbicides on growth and physiological parameters, microbial population, grain and straw yield of transplanted rice. The experiment was laid out in strip plot design with three replications. The treatments comprised of three different methods of irrigation in vertical strips and four methods of weed management practices in horizontal strips. The experimental results showed that, the growth and physiological parameters like plant height, total tillers m⁻², Dry matter production, leaf area index (LAI) and crop growth rate were higher in continuous flooding which is on par with irrigation after 10 cm depletion field water tube method of irrigation. Among weed management practices, weed free check registered higher growth and physiological parameters and it was comparable with the application of PE Pyrazosulfur on ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹. Likewise, microbial colonies observation results showed that, higher bacterial and fungal population were found in 10 cm depletion of field water tube than continuous flooding and actinobacterial colonies were higher in continuous flooding. Among weed management practices, higher fungal and actinobacterial colonies were observed in unweeded control while higher bacterial population were recorded in application of PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25g a.i. ha⁻¹. The higher grain and straw yield (6882 and 7675 kg ha⁻¹) of rice was recorded in continuous submergence coupled with weed free environment. However, field water tube at 10 cm depletion + application of PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ produced the on par yield.

Keywords

Field water tube, Low dose herbicides, Growth and physiological parameters, Microbial population, Yield of rice

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Introduction

Rice (*Oryza sativa* L.) is the important staple food crop accounting 44 % of the total food grains and contributes 20 per cent of share in

national AGDP. A total of 700-1500 mm of water is required per cropping season to cultivate rice under traditional practices in the tropical and subtropical regions of Asia depending on soil texture and prevailing

weather. However, a high amount of irrigation water losses through surface runoff, seepage, and percolation accounts to 50–80 per cent of the total water input under traditional rice cultivation practices. There are a number of alternatives to continuous flooding. One approach which can be used is intermittent irrigation or alternate wetting and drying (AWD). Adoption of AWD methods where the irrigation water is applied in the field on an intermittent basis after the disappearance of ponded water instead of continuous flooding. (Zhang *et al.*, 2009). Several studies have shown that AWD is safe method to limit the water use up to 25% by using of field water tube without reduction in rice yield (Kulkarni 2011) by reducing field level seepage and percolation losses and increase the WUE during the production period.

Rice is cultivated in different ecosystems and weeds are the most important menace to cause low productivity of rice depending upon the different establishment methods. Weeds are highly competitive for moisture, nutrients, light, temperature and space with rice. Furthermore, the negative correlation may occur with crop yield for any delay in weeding. Good control of weed can be attained by employing proper water management practices (Bhan 1981) while maintaining the water regimes under field capacity encourages weed growth (Smith and Fox 1973). Weed composition are mostly altered by the changing water regimes and soil moisture status (Janiya and Moody 1982). Good start and competitive superiority of the crop is obtained through proper herbicides which offers selective and economic control of weeds right from the beginning. In present day agriculture, herbicides like bensulfuron methyl, pyrazosulfuron ethyl and bispyribac sodium are the most commonly used in rice (Saha and Rao 2009) which are highly effective at low rate of application and to

control broad spectrum of weeds and annual sedges.

Materials and Methods

The field experiment was conducted during early *Pishanam* season of 2018-2019 at the BC Block Farm, Agricultural College and Research Institute, Killikulam, Tamil Nadu. The farm is geographically located in the southern part of Tamil Nadu at 8°46' N latitude and 77°42' E longitude at an altitude of 40 m above mean sea level. The soil of the experimental site was sandy clay loam in texture having alkaline pH (8.2) and medium organic carbon (6.2 g kg⁻¹). The soil was low in available nitrogen (244 kg ha⁻¹), medium in phosphorus (22 kg ha⁻¹) and medium in potassium (238 kg ha⁻¹), respectively. Rice variety ASD 16 with the duration of 110 days was used as test variety. Field experiments were laid out in strip plot design with three replications. The treatments comprised of three different methods of irrigation *viz.*, Irrigation after 10 cm depletion of Field Water Tube (FWT) (from surface level) from 10 DAT to 10 days prior to harvest (A₁), Irrigation after 15 cm depletion of Field Water Tube FWT (from surface level) up to maximum tillering stage (30-35 DAT) and 10 cm depletion of FWT to 10 days prior to harvest (A₂), Continuous Submergence (farmers practice) (A₃), respectively in vertical strips and four methods of weed management practices in horizontal strips *viz.*, PE Bensulfuron methyl + Pretilachlor @ 0.6 kg a.i. ha⁻¹ fb POE Bispyribac sodium @ 25g a.i. ha⁻¹ (B₁), PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ (B₂), Weed free check (B₃), Un weeded control (B₄). Growth parameters *viz.*, plant height, total tillers m⁻², dry matter production and physiological parameters *viz.*, leaf area index, crop growth rate and yield were recorded and interpreted here under. Microbial population *viz.*, bacteria, fungi and

actinobacteria in soil were recorded using standard growth medias and discussed here.

Results and Discussion

Growth parameters

Plant height (Table 1)

Plant height is an indicator of growth performance of a crop, as influenced by environment and management factors. The height of plant was increased with the progression of crop growth from AT stage and it reached maximum at harvest stage. Significant effect was found on the plant height due to various irrigation management at all the stages of crop growth. Continuous flooding (A_3) produced significantly taller plants (58.1, 86.6 and 102.3 cm) at AT, PI and at harvest and on par with 10 cm depletion of Field Water Tube (A_1) produced 56.1, 85.2 and 100.2 cm, respectively. Meristematic cells activity and internodes cell elongation stimulated by continuous flooding resulted in higher stem growth rate and in turn promoting the rice height (Chowdhury *et al.*, 2014). The similar result with higher plant height was obtained in continuous submergence treatment than other AWD treatments were reported by Oliver *et al.*, (2008). Irrigation at 15 cm depletion of Field Water Tube (A_2) resulted in shorter plant height of 52.3, 79.0 and 92.2 cm at all growth stages. Any depletion of soil moisture faced by rice at any growth stage before anthesis significantly reduced the plant height reported by Santheepan and Ramanathan (2016) and Oliver *et al.*, (2008).

Imposing of different weed control, the height of plant was maximum in weed free check (B_3) produced 60, 89.5 and 108.9 cm of plant height at AT, PI and harvest, respectively. It was statistically parallel among PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE

Bispyribac sodium @ 25 g a.i. ha⁻¹(B_2) gave 58.7, 88.0 and 105.9 cm, respectively at three stages. This could be attributed to the herbicidal combination control the weed better resulting in enhanced nutrient depletion by the crop reflected on height. The results are in line with Shekhar *et al.*, (2004). Unweeded control (B_4) exhibited significantly lowest plant height of 49.3, 75.0 and 79.0 cm at three phases of observations. The interactions were recorded as non-significant during AT, PI and at harvest.

Total tillers m⁻² (Table 2)

In general, during the beginning tiller production starts slowly, attains to its peak at active vegetative and then started to decline as the age of the crop proceed. Continuous flooding (A_3) produces considerably a greater tillers m⁻² at AT, PI and harvest (255, 313 and 336, respectively). It was governed by better aeration resulted in favourable root growth and more absorption of nutrients as observed from increased uptake of nutrients consequently resulted in more growth and tiller production. It was statistically comparable with irrigation after 10 cm depletion of FWT (A_1) registering 252, 308 and 332 tillers m⁻². Similar result of irrigating the field when water table in the porous tube at 10 cm depletion recorded maximum number of total tillers has been stated by Subramanian *et al.*, (2002). Whereas, the least tillers m⁻² was obtained with adoption of 15 cm depletion of FWT (A_2) at all the crop growth stages (227, 287 and 308 tillers m⁻², respectively).

All the weed management treatments showed distinct superiority over unweeded control in total number of tillers m⁻². Weed free check (B_3) produced reasonable number of tillers of 282, 338 and 361 m⁻², respectively. This result was also corroborated with Patra *et al.*, (2011). It exhibited statistically similar values

with the application of PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ (B2) registering 273, 328 and 355 tillers m⁻² at all the three stages. Reduced weed competition at early stage of rice improved the growth structure such as tiller production. This is in consistence with findings of Singh *et al.*, (2016). Invariably, least number of total tillers (165, 236 and 252 m⁻²) was recorded in unweeded control (B4) at all stages.

Combination of various irrigation and weed control had substantial interaction with each other on tillers m⁻² at AT, PI and harvest stages. Continuous flooding with weed free check (A₃B₃) produced maximum number of tillers (299, 349 and 375, respectively). However, it was statistically identical with irrigation after 10 cm depletion of FWT together with weed free check (A₁B₃) registered more tillers (295, 345 and 368m⁻²). It was governed by lesser weed population and better aeration resulted in favourable root growth and more absorption of nutrients as observed from increased uptake of nutrients consequently resulted in more growth and tiller production. Similar result has been stated by Kunnathadi *et al.*, (2015).

Dry matter accumulation (Table 3)

Generally, plant dry matter increased as the stage of crop progressed to harvest and attained the maximum level at harvest. Continuous flooding (A₃) produced higher DMP registered at AT, PI and at harvest (2284, 7896 and 12796 kg ha⁻¹, respectively). Whereas, it was comparable with 10 cm depletion of FWT (A₁) registering 2193, 7550 and 12231 kg ha⁻¹, respectively. The increase in DMP of rice with AWD might have brought up by loose soil, which facilitates more access to water and nutrients by roots. The correlated outcome of the results was observed by Maragatham and Martin

(2010). The lesser DMP was noticed in 15 cm depletion of FWT (A₂) at all the three stages (1946, 6752 and 11026 kg ha⁻¹, respectively). The same results are in concurrence with Kabir *et al.*, (2008).

Weed free check (B₃) recorded significantly higher DMP of 2361, 8717 and 14431kg ha⁻¹. It was identical with PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POEBispyribac sodium @ 25 g a.i. ha⁻¹ (B2) with a DMP of 2351, 8422 and 13900 kg ha⁻¹, respectively. This is in consistent with the conclusion of Walia *et al.*, (2012). The higher DMP found in the above treatment might be due to the lesser competition by weeds as it might have been killed from their germination phase and keeping weeds at lower densities. The lowest DMP was computed in unweeded control plot, which registered a DMP of 1643, 4889 and 7122 kg ha⁻¹ at AT, PI and at harvest.

Significant interaction effect was noticed at three stages of crop. At AT stage, more amount of DMP was recorded in continuous submergence with PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ with a DMP of 2519kg ha⁻¹. It was comparable with irrigation after 10 cm depletion of FWT with weed free check (A₁B₃) and continuous submergence with weed free check (A₃B₃). At PI and harvest, higher DMP was noticed in continuous submergence with weed free check (A₃B₃) recorded 9389 and 15594 kg ha⁻¹, respectively and it was parallel with continuous submergence with the application of PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ (A₃B₂) registered the DMP of 8925 and 14592 kg ha⁻¹, correspondingly and the lower DMP was produced in Irrigation after 15 cm depletion of FWT with unweeded control treatment (A₂B₄) recorded 4307 and 6358 kg ha⁻¹.

Table.1 Effect of different irrigation and weed management practices on rice plant height (cm)

Treatment	Active tillering						Panicle initiation						At harvest				
	B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean
A ₁	54.5	58.7	61.5	49.8	56.1	A ₁	83.2	90.2	90.1	77.2	85.2	A ₁	99.4	108.6	111.5	81.2	100.2
A ₂	51.2	57.1	55.3	45.7	52.3	A ₂	77.1	83.5	85.7	69.6	79.0	A ₂	93.5	98.6	101.5	75.2	92.2
A ₃	59.3	60.3	63.3	52.3	58.1	A ₃	85.6	90.2	92.6	78.1	86.6	A ₃	104.6	110.5	113.6	80.5	102.3
Mean	54.0	58.7	60.0	49.3			82.0	88.0	89.5	75.0		99.2	105.9	108.9	79.0		
	A	B	A at B	B at A			A	B	A at B	B at A		A	B	A at B	B at A		
SEd	1.8	1.7	2.3	2.1			2.8	2.7	6.1	5.7		3.2	3.0	7.5	6.9		
CD (p=0.05)	3.9	3.8	NS	NS			6.0	5.8	NS	NS		7.0	6.6	NS	NS		

Table.2 Effect of different irrigation and weed management practices on total tillers m⁻²

Treatment	Active tillering						Panicle initiation						At harvest				
	B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean
A ₁	263	283	295	165	252	A ₁	313	333	345	240	308	A ₁	335	365	368	261	332
A ₂	242	250	253	161	227	A ₂	292	315	320	221	287	A ₂	325	338	340	230	308
A ₃	265	285	299	169	255	A ₃	320	335	349	247	313	A ₃	340	363	375	265	336
Mean	257	273	282	165			308	328	338	236		333	355	361	252		
	A	B	A at B	B at A			A	B	A at B	B at A		A	B	A at B	B at A		
SEd	8.4	8.0	9.6	8.2			8.6	7.1	9.9	9.1		10.4	9.9	11.6	10.5		
CD (p=0.05)	18.2	17.4	20.9	17.9			18.7	17.8	21.5	19.8		22.6	21.5	25.2	22.7		

Table.3 Effect of different irrigation and weed management practices on dry matter production (kg ha⁻¹)

Treatment	Active tillering						Panicle initiation						At harvest				
	B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean
A ₁	2280	2363	2462	1668	2193	A ₁	7786	8497	8805	5110	7550	A ₁	12877	14077	14540	7428	12231
A ₂	1962	2170	2191	1462	1946	A ₂	6899	7845	7957	4307	6752	A ₂	11557	13030	13158	6358	11026
A ₃	2389	2519	2430	1798	2284	A ₃	8019	8925	9389	5250	7896	A ₃	13310	14592	15594	7580	12769
Mean	2210	2351	2361	1643			7568	8422	8717	4889		12581	13900	14431	7122		
	A	B	A at B	B at A			A	B	A at B	B at A		A	B	A at B	B at A		
SEd	105.3	101.5	108.5	90.1			314.5	275.2	304.0	281.4		455.4	437.2	475.9	449.6		
CD (p=0.05)	228.5	220.2	235.4	195.6			682.6	597.3	659.8	610.7		988.2	948.8	1032.8	975.6		

Table.4 Effect of different irrigation and weed management practices on leaf area index

Treatment	Active tillering						Panicle initiation				
	B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean
A ₁	2.71	3.67	4.05	2.26	56.1	A ₁	3.54	4.83	5.39	2.66	4.11
A ₂	2.63	3.19	3.24	2.20	52.3	A ₂	3.22	4.58	4.22	2.63	3.66
A ₃	2.74	3.91	4.08	2.31	58.1	A ₃	4.95	4.91	5.49	2.76	4.53
Mean	2.69	3.59	3.79	2.26			3.90	4.77	5.03	2.68	
	A	B	A at B	B at A			A	B	A at B	B at A	
SEd	0.09	0.09	0.12	0.12			0.12	0.12	0.25	0.26	
CD (p=0.05)	0.20	0.21	NS	NS			0.26	0.27	NS	NS	

Table.5 Effect of different irrigation and weed management practices on crop growth rate (kg ha⁻¹ day⁻¹)

Treatment	Active tillering – Panicle initiation						Panicle initiation – at harvest				
	B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean
A ₁	183.5	204.5	211.4	114.7	178.5	A ₁	169.7	186.0	191.2	77.3	156.1
A ₂	164.6	189.2	192.2	94.8	160.2	A ₂	155.3	172.8	173.4	68.4	142.5
A ₃	187.7	213.5	232.0	115.1	187.1	A ₃	176.4	188.9	206.8	77.7	162.5
Mean	178.6	202.4	211.9	108.2			167.1	182.6	190.5	74.5	
	A	B	A at B	B at A			A	B	A at B	B at A	
SEd	5.6	5.2	5.7	4.5			4.9	4.3	10.7	9.8	
CD (p=0.05)	12.1	11.2	12.2	10.9			10.7	9.3	NS	NS	

Table.6 Effect of different irrigation and weed management practices on microbial population soil (cfu g⁻¹)

Treatment	Bacteria (10 ⁶ cfu g ⁻¹)						Fungi (10 ⁶ cfu g ⁻¹)						Actinobacteria (10 ⁶ cfu g ⁻¹)				
	B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean
A ₁	13x10 ⁶	15x10 ⁶	10x10 ⁶	12x10 ⁶	13x10⁶	A ₁	6x10 ³	8x10 ³	4x10 ³	9x10 ³	7x10³	A ₁	3x10 ²	4x10 ²	2x10 ²	8x10 ²	4x10²
A ₂	12x10 ⁵	14x10 ⁵	9 x10 ⁵	11x10 ⁵	12x10⁵	A ₂	5x10 ³	6x10 ³	3x10 ³	7x10 ³	5x10³	A ₂	5x10 ²	6x10 ²	2x10 ²	7x10 ²	5x10²
A ₃	7 x10 ⁴	7 x10 ⁴	4 x10 ⁴	5 x10 ⁴	6x10⁴	A ₃	3x10 ²	4x10 ²	2x10 ²	5x10 ²	4x10²	A ₃	6x10 ¹	8x10 ¹	3x10 ¹	9x10 ¹	7x10¹
Mean	11x10⁵	12x10⁶	8 x10⁵	9x10⁶			5x10³	6x10³	3x10²	7x10³		5x10²	6x10²	2x10²	8x10²		

*Data not statistically analyzed

Table.7 Effect of different irrigation and weed management practices on grain and straw yield (kg ha^{-1}) of transplanted rice

Treatment	Grain yield (kg ha^{-1})						Straw yield(kg ha^{-1})				
	B ₁	B ₂	B ₃	B ₄	Mean		B ₁	B ₂	B ₃	B ₄	Mean
A ₁	6245	6720	6880	3558	5851	A ₁	7110	7553	7969	5110	7550
A ₂	5210	5995	6520	2968	5173	A ₂	6054	6920	7957	4307	6752
A ₃	6412	6720	6859	4898	6222	A ₃	7306	7678	9389	5250	7896
Mean	5956	6478	6753	3808			6823	7384	8717	4889	
	A	B	A at B	B at A			A	B	A at B	B at A	
SEd	256.8	235.7	249.6	235.3			305.4	289.5	304.0	281.4	
CD (p=0.05)	557.3	511.4	541.6	510.6			662.8	628.2	659.8	610.7	

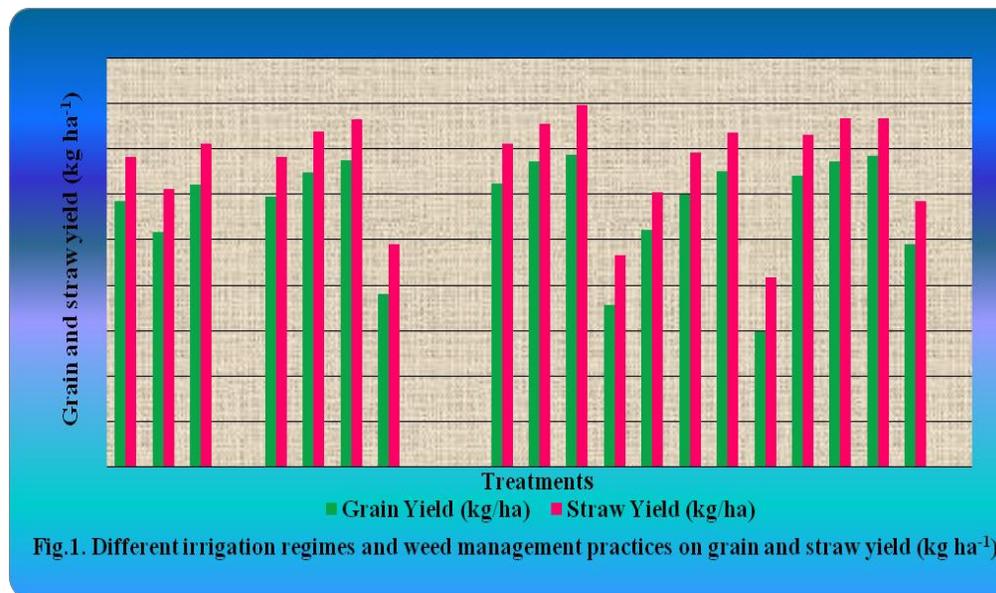


Fig.1. Different irrigation regimes and weed management practices on grain and straw yield (kg ha^{-1})

Physiological parameters

Leaf area index (Table 4)

Measurement of leaf area and assessment of LAI are the basic tools for growth analysis. The LAI varied appreciably in a predictable manner with the plant height as one of the factors for calculation. Among the different irrigation management practices, largest plant canopy was registered with continuous submergence (A_3) recorded LAI of 3.26 and 4.53, respectively. The increased LAI might have been brought up by favourable moisture regimes and more soil nutrient uptake, belated senescence of the leaves with higher photosynthetic rate which resulted in better LAI reported by Thakur *et al.*, (2010). The next largest plant canopy was found in irrigation after 10cm depletion of FWT (A_1) with a LAI of 3.17 and 4.11. The above two treatments are statistically comparable with each other. Water stress affects photosynthetic rate (P_n) which supports to a reduction of photosynthetic rate in plants grown under AWD conditions but saturated or above water condition did not affect photosynthetic rate, transpiration rate. This is agreed with the conclusion of Okuma *et al.*, (2011). This was followed by irrigation after 15 cm depletion of FWT (A_2) recorded LAI of 2.82 and 3.66 at AT and PI stages.

Significantly higher LAI values of 3.79 and 5.03 at AT and PI, respectively was noted with weed free check (A_3). It was statistically identical with PE Pyrazosulfuron ethyl @ 20g a.i. ha^{-1} fb POE Bispyribac sodium @ 25 g a.i. ha^{-1} evidenced 3.59 and 4.77, respectively. This is as a result of better control of weeds which reduce the competition for growth component of rice. (Satyanarayana Reddy *et al.*, 2013) made related conclusions. Lowest LAI of 2.26 and 2.68 at AT and PI stages was recorded in unweeded control (A_4).

Irrigation and weed management practices had substantial interaction with each other at panicle initiation stage. Higher LAI was recorded in continuous flooding with weed free check (A_3B_3), which was identical with irrigation after 10 cm depletion of FWT with weed free check (A_1B_3) produced largest plant canopy of 5.49 and 5.39, respectively at panicle initiation stage. The proper soil aeration maintained under water saving irrigation facilitated production of more tillers number and consequently higher photosynthetic rate for augmented LAI was stated by Thiyagarajan *et al.*, (2002).

Crop growth rate (CGR) (Table.5)

Crop growth rate (CGR) is a gathering of daily radiation interception, radiation use efficiency and leaf area index. Crop growth rate is representing photosynthetic efficiency of a plant, which depend upon the DMP of rice. The CGR was faster up to PI and thereafter the growth rate was rather slow. Among different irrigation management practices, continuous flooding (A_3) noticed higher CGR of 187.1 and 162.5 $kg\ ha^{-1}\ day^{-1}$ at AT to PI and PI to harvest stage, respectively. It was statistically similar with irrigation after 10 cm depletion of FWT (A_1) (178.5 and 156.1 $kg\ ha^{-1}\ day^{-1}$). The above ground parts of the plant are positively influenced by better root growth and due to increased leaf area, CGR was increased. These conclusions are in harmony with Okuma *et al.*, (2011). Lesser CGR of 160.2 and 142.5 $kg\ ha^{-1}\ day^{-1}$ was recorded under irrigation after 15 cm depletion of FWT (A_2) at both the stage, respectively.

Weed free check (B_3) much produced higher crop growth rate at AT to PI and PI to harvest stage (211.9 and 190.5 $kg\ ha^{-1}\ day^{-1}$) respectively. It was statistically comparable with PE Pyrazosulfuron ethyl @ 20g a.i. ha^{-1} fb POE Bispyribac sodium @ 25g a.i. ha^{-1}

accounting 202.4 and 182.6 kg ha⁻¹day⁻¹. Next to these treatments, application of PE Bensulfuron methyl + Pretilachlor @ 0.6 kg a.i. ha⁻¹ fb POE Bispyribac sodium @ 25g a.i. ha⁻¹ recorded the crop growth rate values 178.6 and 167.1 kg ha⁻¹day⁻¹, respectively). Whereas, unweeded control recorded lower CGR values of 108.2 and 74.5 kg ha⁻¹ day⁻¹ at AT to PI and PI to harvest stage.

Significant interaction between irrigation and weed management was noticed only during AT to PI stage. Continuous flooding along with weed free check (A₃B₃) got higher CGR of 232 kg ha⁻¹day⁻¹. It was followed by continuous flooding with PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ (A₃B₂)(213.5 kg ha⁻¹day⁻¹).

The same result was also corroborated with Ali *et al.*, (2008) who detailed that more dry matter production attained by optimal irrigation resulted in more CGR due to more carbohydrate assimilation and lesser competition among the plants. Lesser CGR was observed with irrigation after 15 cm depletion of FWT with unweeded control (A₂B₄) produced 94.8 kg ha⁻¹day⁻¹.

Microbial Population of soil

Bacterial Population (Table 6)

Among different irrigation management practices, soil bacterial population significantly increased under FWT method of irrigation than continuous flooding water after harvest of crop. The increasing bacterial population were dominated in order of irrigation after 10 cm depletion of FWT (A₁) > irrigation after 15 cm depletion of FWT (A₂) > continuous flooding (A₃). This could be attributed due to the water regimes providing favourable environment for soil microorganism.

Regarding weed management, weed free check (B₃) recorded lower bacterial population significantly over other weed control. Application of PE Pyrazosulfuron ethyl @ 20 g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ (B₂) recorded significantly higher bacterial population followed by PE Bensulfuron methyl + Pretilachlor @ 0.6 kg a.i. ha⁻¹(B₁) and unweeded control plots (B₄).

Fungal population (Table 6)

Significantly higher fungal colonies were found under FWT method of irrigation regime than the plots under continuous flooding after crop harvest. Irrigation after 10 cm depletion of FWT (A₁) recorded higher fungal population followed by irrigation after 15 cm depletion of FWT (A₂) method of irrigation.

Unweeded control (B₄) recorded greater fungal populations significantly over other weed control. Among the herbicidal treatments, larger fungal colonies were observed in application of PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ (B₂) and it was followed by the application of PE Bensulfuron methyl + Pretilachlor @ 0.6 kg a.i. ha⁻¹ fb POE Bispyribac sodium @ 25g a.i. ha⁻¹ (B₁). Whereas, the least fungal population was found in weed free check (B₃).

Actinobacteria (Table 6)

With respect to irrigation management, the soil actinobacteria population were significantly higher in continuous flooding after crop harvest than FWT method of irrigation. Comparing FWT method of irrigation, irrigation after 10 cm depletion of FWT (A₁) recorded higher population and it was followed by irrigation after 15 cm depletion of FWT (A₂).

Significantly higher actinobacteria population was recorded under unweeded control compared to weed control treatments. These higher Actinobacteria colonies were dominated in weedy check might be due to the non-disturbance of soil environment caused in weedy check. The results are in line with Kumar (2012). PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ showed more actinomycetes population and it was followed by PE Bensulfuron methyl + Pretilachlor @ 0.6 kg a.i. ha⁻¹ fb POE Bispyribac sodium @ 25g a.i. ha⁻¹ (B₁). While, the least actinobacteria population was found in weed free check (B₃).

Grain and straw yield (Table 7)

Grain and straw yield are the key parameters of any crop, which was reflected by the impact of crop growth parameters and yield contributing characters that are affected by various management option.

The rice grain and straw yield was greatly influenced by irrigation management treatments. Among, continuous flooding (A₃) recorded higher grain and straw yield of 6222 & 7127 kg ha⁻¹. This could be attributed due to taller plants and in turn more drymatter accumulation under continuous flooding. However, the harvest index was not affected by different irrigation regimes. These results are in agreement with Son *et al.*, (2008). But the equivalent yield was observed with irrigation after 10 cm depletion of FWT (A₁) produced 5851 & 6748 kg of grain and straw yield ha⁻¹. The lower yield of 5173 & 6127 kg ha⁻¹ was noticed with irrigation after 15 cm depletion of FWT (A₂).

Imposing of different weed management, weed free check (B₃) significantly produced maximum grain and straw yield of 6753 & 7568 kg ha⁻¹. It was identical with the

application of PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ (B₂) (6478 & 7381 kg ha⁻¹). It was due to considerable improvement of all attributed yield attributing characters and also by reducing the crop-weed competition. Close accordance with Kumar *et al.*, (2014). The unweeded These outcomes are in check (B₄) resulted in lowest grain and straw yield of 3808 & 4897 kg ha⁻¹.

Among the different irrigation and weed management combinations, continuous flooding with weed free check (A₃B₃), registered more grain and straw yield of 6882 & 7675 kg ha⁻¹. However, it was statistically equivalent with 10 cm depletion of FWT (A₁) + PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ (A₁B₂) and continuous flooding with PE Pyrazosulfuron ethyl @ 20g a.i. ha⁻¹ fb POE Bispyribac sodium @ 25 g a.i. ha⁻¹ (A₃B₂). The results are in line with the findings of Uphoff (2006) who found that the higher grain and straw yields ultimately attributed to the series of repeated wetting and drying were effect on beneficial increase of nutrient availability leading to better growth and development of the crop. Irrigation after 15 cm depletion of FWT coupled with unweeded control (A₂B₄) significantly found lower grain and straw yield of 2968 & 4177 kg ha⁻¹.

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