CHANGES IN GROWTH PARAMETER AND YIELD COMPONENT OF MID DURATION RICE UNDER DIFFERENT LEVEL OF N, P AND K, GROWN UNDER AEROBIC CONDITION

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Abstract: The experiment was conducted during *kharif*season of 2010 at Instructional Cum Research Farm IGKV Raipur to investigate the "Effect of CPE Based Irrigation Schedules and Nutrient Management Practices On Aerobic Rice." The 24 treatment combinations consisted of 3 CPE based irrigation schedules *i.e.* @ 150% CPE, @ 100% CPE and @ 75% CPE and 8 nutrient management practices *i.e.* $N_0 P_{60} K_{100}$, $N_{60} P_{60} K_{100}$, $N_{120} P_{60} K_{100}$, $N_{180} P_{60} K_{100}$, $N_{120} P_{30} P_{100}$, $N_{120} P_0 K_{100}$, $N_{120} P_{60} K_{50}$ and $N_{120} P_{60} K_0$. The split plot design was followed with 3 replications having CPE based irrigation schedules as main plot treatment and nutrient management practices as sub plot treatment. A medium duration high yielding rice variety Mahamaya was taken as a test crop. The CPE based irrigation schedules did not influence significantly the growth parameters *i.e* plant height, No. of tillers, leaf area, dry matter accumulation and SPAD value. The growth parameters found to be equally effective under all irrigation schedules. Moreover effective tillers, grains panicle^{-1}, test weight, sterility per cent and yields of grain and straw remained at par under all the irrigation schedules. The nutrient management practices significantly affected the growth, yield and nutrient concentration and uptake of rice. The application of $N_{180}P_{60}K_{100}$, significantly increased the plant height, No. of tillers, leaf area, dry matter accumulation ,SPAD value at all the growth stages as compared to treatments of $N_0P_{60}K_{100}$, $N_{120}P_0K_{100}$ and N_{120} $P_{60}K_0$. The nutrients levels of $N_{120}P_{60}K_{50}$ and $N_{120}P_{60}K_{100}$ produced comparable plant height, No. of tillers, at all the growth stages to that of $N_{180}P_{60}K_{100}$. These nutrient levels also found to equally effective for increasing yield components, grain yield, N, P and K concentration in grain and straw. The uptake of these nutrients also increased at aforesaid levels of nutrients. The increase in yield was mainly associated with significant increase in number of leaves, leaf area and dry matter accumulation.

Keywords: Aerobic rice, cumulative pan evaporation, irrigation schedules, nutrient, growth parameter, yield.

INTRODUCTION

Rice is the most important staple in Asia where it provides 35-80 per cent of total calorie uptake (IRRI, 1997).Rice *(Oryzasativa*L) is considered as the 'Global Grain' in 89 nations and its production is almost 518 m t every year and is an important food for more than half of the global population. In India it occupies about 44.6 m ha with a production of 86.0 m t and it continuous to hold the key to sustain food production by contributing 20 to 25 per cent of agriculture GDP and assures food security in India for more than half of the total production. In India, rice is grown under three major ecosystems: rainfed upland (16%), irrigated land (45%) and rainfed lowland (39%), with a productivity of 0.87, 2.24, and 155 t ha^{-1}, respectively.

Chhattisgarh is popularly known as the "rice bowl". It has geographical area of 13.51 m ha of which 5.9 ha is under cultivation. In Chhattisgarh, rice is mainly grown under rainfed ecosystems, which covers 74,97 and 95 per cent cropped area of Chhattisgarh plain, Bastar plateau and Northern hill zones , respectively. Rice occupies an area of 3.5 m ha with production of 4.5 m t and productivity of 12.6 q ha^{-1} (Anonymous, 2010). Chhattisgarh state contributes 5.26 per cent of total rice production of the country. In Chhattisgarh, about 85 to 90 per cent of the rice crop is direct seeded.The use of irrigation water was reduced by 50 per cent and yield has been maintained. Thus, the productivity of irrigation water is 2-3 times higher than achieved with lowland rice. The rice in general considered a water loving plant and requires huge amount of water. In most of the rice growing area, it is grown under submerged condition encourages huge amount of water loss from the rice field. Submergence of 5-10 cm water during land preparation and also crop establishment encourages the large losses of water by seepage, percolation and evaporation. The estimated value of water requirement vary with soil type, rainfall, variety and other climatic variables and for different parts of India the requirement ranged between 1500 and 2500 mm water (Lourdraj and Bayan ,1999). However, the exact practice to be followed depends upon factors like climate, soil and crop growth stage. Technologies like saturated soil culture and alternate wetting and drying are found promising but required prolong periods of flooding. Traditional lowland rice with continuous flooding in Asia has relatively high water inputs. Because of increasing water scarcity, there is a need to develop alternative system that requires less water. "Aerobic rice" is a new concept of growing rice it is a high yielding rice grown in non- flooded soil, aerobic soil under high external inputs and supplementary irrigation when natural rainfall is insufficient. Aerobic or upland rice direct seeded in non-puddled, non- flooded fields. It requires less water and labour than flooded rice. The total amounts of water inputted during the crop growth season (excluding the 105 mm at land preparation) were low (470-586 mm) compared with typical values of 1000-1500 mm for lowland rice (Bouman and Tuong, 2001).

Aerobic rice reduces water inputs in rice field by cutting down the unproductive water losses caused due to seepage and percolation. Experiments on aerobic rice have shown that water inputs were more than 50 per cent lesser than maintaining continuous submergence. On the other hand, it has been also reported that rice yields were not consistent, when grown under aerobic condition. Therefore, it is essential to work out proper irrigation schedules for aerobic rice cultivation.

The nitrogen, phosphorus and potassium are essential inputs and their deficiency is the major constraints in the successful cultivation of rice. Hence, there is need for application of these nutrients in balance quantity for attaining optimum growth and development and enhancing the yield of rice but its uptake greatly varies under different moisture regimes .Not only this, but also a proper ratio of these nutrients are required to obtain optimum response in terms of grain yield of rice. It is well establish fact that advantages of these nutrients can be obtained under optimum or sufficient moisture levels as its uptake greatly varies under different moisture regimes.

MATERIAL AND METHOD

This chapter deals with the concise description of the materials used and techniques adopted during the course of investigation. The present investigation entitled **"Effect of cumulative Pan Evaporation (CPE) Based Irrigation schedules and Nutrient Management Practices on Aerobic Rice"** was conducted at the Instructional Cum Research Farm, IGKV, Raipur, Chhattisgarh during the *kharif* season (30^{th}, June to 11^{th}, November, 2010).

Geographically Raipur is situated in the centre of Chhattisgarh and lies between 21^0 $16'$ N latitude and 81^0 $26'$ E longitude with an altitude of 289.56 metres above the mean sea level.

Raipur comes under dry moist sub-humid regions. It has a seasonal average rainfall of 1325 mm (based on 80 years mean). Nearly 85 per cent of the annual rainfall is received from third week of June to mid of September. The maximum and minimum temperature goes to 46^0C and 6^0C, respectively in the months of May and December or January.

During crop growth period, the maximum temperature varied between 26.5^0C to 35.7^0C, respectively. The minimum temperature ranged between 19.2^0C to 26.0^0C. Crop received sunshine hours of 2.1 to 8.5 per day. The maximum and minimum humidity during the crop period was 95 and 52 percent, respectively. A total of 1040.5 mm rainfall was received during the crop period.

The experiment was laid out at the Instructional Cum Research Farm, College of Agriculture IGKV, and Raipur in bunded rice block under irrigated condition. The gross area under experiment was 1957.5 m^2.

A medium duration high yielding rice variety "Mahamaya" released from IGKV, Raipur was taken as test crop .The variety has been graded as bold seeded and mature in 132-135 days. The variety has been widely accepted for the *"Poha"* purpose.

Pre-harvest observation

Plant height (cm)

The plant height of ten randomly selected plants from each plot was measured of an internal of 30 days starting from 30, 60 and 90 DAS and finally at harvest. The average plant height was presented in table at each stage.

Number of tillers (m^{-2})

Number of tillers m^{-2} were counted at 30, 60 and 90 DAS and at harvest at four places already demarked with bamboo pegs in each plot and then means was calculated.

Post-harvest observation

Number of effective tillers (m^{-2})

The observation on number of panicle bearing tillers was made at harvest. Panicle bearing tillers were counted at four places already marked with bamboo pegs in each plot and then mean was calculated.

Grains panicle^{-1}

The ten panicles of the tagged plant were threshed, total grains panicle^{-1} were counted and presented.

Sterility percentage (%)

The number of filled and unfilled grains per panicle was counted separately from the ten tagged plants in each plot and sterility was computed with the formula.

Test weight (1000 grain weight) (g)

A random grain samples were taken from the produce of each net plot. Out of samples, 1000 grains were counted from each net plot and same were dried over at 60^0C to constant weight, thereafter weight so obtained was noted as 1000-grain weight (test weight).

Grain and straw yield (q ha^{-1})

The clean grain obtained after threshing and winnowing from each net plot was weighed. The results were expressed on 14 per cent moisture basis. The straw yield was obtained by substracting weight of the grain yield from the total weight of the bundle. The grain and straw yield ha^{-1} were calculated by multiplying the net plot yield with factor 604 and then converted in to q ha^{-1}.

Harvest index (%)

Harvest index was computed as the ratio of economic yield *i.e.* grain yield to the total biomass *i.e.* biological yield (grain and straw) from same area and expressed in per cent.

Statistical analysis

The experiment was laid out in split plot design (SPD). The data obtained from various characters under study were analysed by the method of analysis of variance as described by Gomez and Gomez (1984). Analysis of variance (ANOVA) table was prepared in the following way for each character.

Table 1. Analysis of variance table

ANOVA Table					
Source of variation	d.f.	S.S.	M.S.S.	F cal	F tab%
Replication	2				
Main plot	2				
E(a)	4				
Sub plot	7				
I (m X S)	14				
E (b)	42				
Total	71				

In order to compare the mean value of treatments, standard error and critical values were calculated as follows:

(a) Standard error of mean SEm± = $\sqrt{\frac{EMS}{r}}$

(b) Critical difference (C.D.) = SE (d) x t value at 5% error (df)

(c) Coefficient of variation (C.V.%) = $\sqrt{Ve}$/ gm x 100

Where,

df	=	Degree of freedom
S.S.	=	Sum of square
M.S.S.	=	Mean sum of square
Ve	=	Error variance
r	=	Replication
GM	=	General mean
EMS	=	Error mean square

RESULT AND DISSCUSSION

Plant height (cm)

The CPE based irrigation schedules did not influence the plant height significantly at 30, 60 and 90 DAS and at harvest. The irrigation water supplied under different treatments supported with frequent occurrence of rain fall and high water table failed to create any water deficit to the plant, thus significant difference among the water treatments was not observed. The similar findings have been also reported by Nayak*et al.* (1981). An average of 58.95 cm, 102.88 cm, 120.07 cm and 150.85 cm plant height was observed at 30, 60 and 90 DAS and at harvest, respectively.

Table 2. Plant height at different stages of rice as influenced by CPE based irrigation schedules and nutrient management practices

Treatment		Plant height (cm)			
		30 DAS	60 DAS	90 DAS	At harvest
CPE based Irrigation schedules					
C_1	150% CPE	58.42	105.04	124.83	148.46
C_2	100%CPE	57.96	100.38	118.92	153.13
C_3	75%CPE	60.58	103.23	116.46	151.96
SEm±		**0.69**	**1.41**	**2.86**	**1.61**
CD at 5%		**NS**	**NS**	**NS**	**NS**
Nutrient management practices					
F_1	N_0 P_{60} K_{100}	44.67	77.22	106.33	124.33
F_2	N_{60} P_{60} K_{100}	59.89	105.89	120.78	152.22
F_3	$N_{120}P_{60}K_{100}$	63.11	110.89	126.56	163.11
F_4	N_{180} P_{60} K_{100}	64.17	111.78	128.11	163.67
F_5	N_{120} P_{30} K_{100}	60.89	108.22	122.44	157.00
F_6	N_{120} P_0 K_{100}	56.56	98.67	113.44	141.67
F_7	N_{120} P_{60} K_{50}	62.89	109.44	124.53	159.67
F_8	N_{120} P_{60} K_0	59.78	102.11	118.33	147.78
SEm ±		**1.40**	**0.98**	**1.33**	**1.41**
CD at 5%		**4.01**	**2.80**	**3.80**	**4.03**

Among different nutrient management practices, significant effect of treatments was observed at 30, 60 and 90 DAS and at harvest. At 30 DAS, nutrient level of N_{180} P_{60} K_{100} (64.17cm) registered significantly taller plants as compared to treatments of N_0 P_{60} K_{100}, N_{120} P_0 K_{100} and N_{120} P_{60} K_0. The nutrient levels N_{120} P_{30} K_{100}, N_{120} P_{60} K_{50} and N_{120} P_{60} K_{100} produced comparable plant height to that of N_{180} P_{60} K_{100}. The nutrient level of N_0P_{60} K_{100} gave lowest plant height at all the stages of crop. While at 60 and 90 DAS and at harvest, treatments of N_{120} P_{60} K_{50}, N_{120} P_{60} K_{100} and N_{180} P_{60} K_{100} found to be equally effective for producing the plant height. The remaining treatments were inferior to that of N_{180} P_{60} K_{100} at these stages. In present set of experiment, significantly higher plant height was observed under the treatment of N_{180} P_{60} K_{100} at early stages (30 and 60 DAS), while, N_{120} P_{60} K_{50} at 90 DAS and at harvest. The similar findings have been also reported by Reddy *et al.* (1985) and Singh *et al.* (1996).

Number of tillers (m^{-2})

The CPE based irrigation schedule did not influence the tiller production of rice plant at either stage of the crop growth.

In general tillers production rate was higher between 30-60 DAS followed by 60-90 DAS. Thereafter decline in tillers number was noticed under at harvest stage of the crop.

As regards to nutrient management practices, application of N_{180} $P_{60}K_{100}$, produced the higher number of tillers at all the stages. At 30 DAS, treatment of N_{120} P_{60} K_{100} and N_{120} P_{60} K_{50} produced statistically similar number of tillers to that of N_{180} P_{60} K_{100}. The remaining treatments were inferior to that of N_{120} P_{60} K_{100} while at 60 DAS, almost similar trend was noticed to that at 30 DAS. Further increase in crop age to 90 DAS, treatments of N_{120} P_{60} K_{100} and N_{120} P_{60} K_{50} found to be equally effective to that of N_{180} P_{60} K_{100}, which produced the highest number of total tillers. The remaining treatments were inferior to that of N_{120} P_{60} K_{100} at this stage. Almost similar trend exist at 90 DAS. At harvest stage, the application of N_{180} P_{60} K_{100} produced the highest number of tillers, which was significantly superior than other treatments except application of N_{120} P_{60} K_{100}. The lowest number of total tillers were observed under N_0 P_{60} K_{100}. The similar findings have been also reported byShivay and Singh (2003).

Table 3. Number of tillers at different stages of rice plant as influenced by CPE based irrigation schedules and nutrient management practices

Treatment	Number of tillers (m^{-2})			
	30DAS	**60 DAS**	**90 DAS**	**At harvest**
CPE based Irrigation schedules				
C_1 150% CPE	239.31	287.13	294.27	287.40
C_2 100%CPE	237.41	286.40	293.80	285.47
C_3 75%CPE	235.41	286.33	291.93	284.41
SEm ±	**1.32**	**1.00**	**1.43**	**1.92**
CD at 5%	**NS**	**NS**	**NS**	**NS**
Nutrient management practices				
F_1 N_0 P_{60} K_{100}	235.96	280.08	284.75	262.42
F_2 N_{60} P_{60} K_{100}	244.08	298.42	303.45	287.34
F_3 $N_{120}P_{60}K_{100}$	248.09	304.78	307.44	294.44
F_4 N_{180} P_{60} K_{100}	249.05	305.75	308.34	296.33
F_5 N_{120} P_{30} K_{100}	245.07	299.92	305.75	290.37
F_6 N_{120} P_0 K_{100}	237.67	283.42	297.58	283.00
F_7 N_{120} P_{60} K_{50}	247.09	301.68	306.38	291.43
F_8 N_{120} P_{60} K_0	240.00	288.50	298.00	283.50
SEm ±	**1.43**	**1.35**	**1.27**	**0.96**
CD at 5%	**4.14**	**3.92**	**3.68**	**2.77**

Yield components, grain and straw yields

The different CPE based irrigation schedules and nutrient management practices in rice significantly affected the yield components and grain yield of rice .As regards to CPE based irrigation schedules, the different irrigation scheduled failed to bring significant increase in effective tillers, grains panicle^{-1}, test weight, sterility percentage, yield and straw yield. All the irrigation schedules provided aerobic condition and enhance aerobic activities of micro-organism which enhances root activities, producing longer panicle with more grains. This ultimately led to increased grain yield. The similar finding has been also reported by (Subramanian *et al.*, 1978). The rainy season water table was also high and crop under all the treatments fulfil their evaporating demand and thus produced similar yield components and yields of grain and straw. The similar findings have been reported by Guled (1993). The increase in grain yield was mainly associated with the significant increase in effective tillers, grains panicle^{-1}, test weight with reduced sterility percentage.

In respect to nutrient management practices, significant difference exists among the treatments for yield components and grain yield of rice. The application of N_{180} P_{60} K_{100} produced the highest grain yield (59.36 q ha^{-1}) which was on par to that of nutrient levels of N_{120} P_{60} K_{100} (58.55 q ha^{-1}) and N_{120} P_{60} K_{50} (57.84 q ha^{-1}). The remaining treatments were inferior to these treatments. The similar was the effects of these treatments on grains $panicle^{-1}$. In addition to these nutrient levels, application of N_{60} P_{60} K_{100} and N_{120} P_{30} K_{100} produced the comparable number of effective tillers and test weight. The trend for straw yield and harvest index was similar to that of grain yield. The lowest sterility percentage was observed under the treatment of N_{120} P_{60} K_{100}, which was comparable to the application of N_{120} P_{60} K_{50}. On the other hand, highest sterility percentage was noted due to application N_0 P_{60} K_{100}, which was at par to dose of N_{180} P_{60} K_{100}, N_{120} P_0 K_{100} and N_{120} P_{60} K_0. The lowest grain yield, effective tillers, panicle weight, test weight was recorded under the nutrient level of N_{100} P_{60} K_{100}. The data are in agreements with the findings of Rao (1990).

The plant height, leaf area and SPAD value remained high due to application of N_{120} P_{60} K_{100}, which helped in increasing the grain yield of rice. All these parameters were beneficial to production and transmission of photosynthesis towards grain. Further increase in nutrients levels of N_{180} P_{60} K_{100} failed to increase yield component and grain yield.The similar findings have been also reported by Pandey*et al.* (1998). The higher grain yield can be described to higher number of effective tillers, fertile grains, test weight and reduced sterility percentage. Among the individual nutrient, when treatment of N_{120} P_{60} K_{100} and N_0 P_{60} K_{100} were compared, grain yield increased to the extent of 120.52% due to application of nitrogen, while comparison of N_{120} P_{60} K_{100} with N_{120} P_0 K_{100} revealed the yield increased to the tune of the 61.65%. The comparison of N_{120} P_{60} K_{50} with N_{120} P_{60} K_0 indicated that the yield increased to the tune of 59.69%. The increased yield due to application of these nutrients on rice have also been reported by Sharma and Tomar (1997).

Table 4: Yield components, grain and straw yields of rice as influenced by CPE based irrigation schedules and nutrient management practices

Treatment	No. of effective tillers (m^{-1})	Grains $Panicle^{-1}$ (No)	Test weight (g)	Sterility (%)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
CPE based Irrigation schedules							
C_1 150 % CPE	253.60	114.22	29.15	14.69	47.25	74.28	38.88
C_2 100 % CPE	252.00	112.21	29.13	14.60	46.05	72.89	38.72
C_3 75 % CPE	251.00	111.70	28.99	14.55	45.09	71.98	38.52
SEm ±	**5.05**	**1.04**	**0.27**	**0.13**	**1.06**	**1.89**	**0.21**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Nutrient management practices							
F_1 N_0 P_{60} K_{100}	230.98	85.88	26.44	16.59	26.55	67.30	28.29
F_2 N_{60} P_{60} K_{100}	257.48	112.55	29.33	14.05	47.29	69.90	40.35
F_3 $N_{120}P_{60}K_{100}$	263.48	125.66	29.98	11.96	58.55	77.99	42.88
F_4 N_{180} P_{60} K_{100}	264.48	130.21	30.08	16.19	59.36	81.80	42.05
F_5 N_{120} $P_{30}K_{100}$	255.44	115.21	29.64	13.65	48.70	70.81	40.75
F_6 N_{120} P_0 K_{100}	240.62	99.55	28.49	16.11	34.56	67.60	33.83
F_7 N_{120} P_{60} K_{50}	261.91	122.55	29.90	12.15	57.84	79.81	42.02
F_8 N_{120} P_{60} K_0	243.22	110.10	28.86	16.25	36.22	69.20	34.36
SEm ±	**4.52**	**2.28**	**0.31**	**0.28**	**1.40**	**2.23**	**0.30**
CD at 5%	**12.91**	**6.51**	**0.90**	**0.78**	**3.99**	**6.35**	**0.88**

DISCUSSION

The CPE based irrigation schedules did not influence significantly the growth parameters *i.e* plant height, no. of tillers, leaf area, dry matter accumulation and SPAD value. Irrigation water supplied under different treatments supported with frequent occurrence of rainfall and high water table failed to create any water deficit to the plant. However, all the growth parameters found to be equally effective under all irrigation schedules. Moreover effective tillers, grains $panicle^{-1}$, test weight, sterility per cent and yields of grain and straw remained at par under all the irrigation schedules. The irrigation scheduled @ 150% CPE gave the highest water requirement, irrigation requirement and effective rainfall. On the other hand highest water use efficiency was observed under the irrigation scheduled @ 75% CPE.

The nutrient management practices significantly affected the growth, yield and nutrient concentration and uptake of rice. The application of $N_{180}P_{60}K_{100}$, significantly increased the plant height, total tillers, leaf area, dry matter accumulation and SPAD value at all the growth stages as compared to treatments of $N_0P_{60}K_{100}$, $N_{120}P_0K_{100}$ and N_{120} $P_{60}K_0$. The nutrients levels of $N_{120}P_{60}K_{50}$ and $N_{120}P_{60}K_{100}$ produced comparable plant height, total tillers, leaf area, dry matter accumulation and SPAD value at all the growth stages to that of $N_{180}P_{60}K_{100}$. These nutrient levels also found to equally effective for increasing yield components, grain yield, N, P and K concentration in grain and straw. The uptake of these nutrients also increased at aforesaid levels of nutrients. The increase in yield was mainly associated with significant increase in number of leaves, leaf area and dry matter accumulation.

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