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EFFECT OF IRRIGATION REGIMES AND PLANTING GEOMETRY ON NUTRIENT AVAILABILITY, UPTAKE OF NUTRIENTS AND GRAIN YIELD IN RICE

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ABSTRACT

Investigations carried out at Agricultural Research Station. Aliyarnagar, Tamil Nadu. India during 1993-94 and 1994-95 revealed that irrigation scheduled one day after disapperance of ponded water. closer plating of 50 hills m^{-2} and planting of four seeldings $hill^{-1}$ recorded higher uptake of N. P and K. Planting method, either rectangular or equidistance did not influence the uptake of nutrients. The varieties CO 45 and ADT 38 absorbed more N.P and K than IR 20. Soil available nutrients of N and K were not influenced by irrigation regimes. However, soil available P was higher at the irrigation regime of three days after disappearance of ponded water. Soil available Phosphorus and Potassium wre higher under wider planting of 33 hill m^{-2}. Available P was higher when planted with two or six seedling $hill^{-1}$. Soil available N,P and K were higher when IR 20 was raised than CO 45 and ADT 38. Irrigation one day after disappearance of ponded water recorded higher gain yield compared to irrigation three days after disappearance of ponded water. Planting geometry did not influence the rice yield. Planting 4 seedling $hill^{-1}$ recorded higher grain yield compared to planting 2 or 6 seedlings $hill^{-1}$. CO 45 and ADT 38 recorded higher grain yield compared to IR 20.

KEY WORDS: Rice, Irrigation regimes, Planitng geometry, Nutrient availability, Nutrient uptake

Rice is the most important food grain of our country grown in about 40 million hectares. Water management plays a major role in rice production directly as its influence on other factors. Dry matter production of rice has linear relationship with water applied (Aragon and De Datta, 1982). Irrigation influences mineralisation of soil N and is enhanced both under aerobic and flooded conditions (Sahrawat. 1981). Reports on increased P availablity due to flooding (Iruthayaraj and Morachan, 1980) as well as decrease in P availablity (Mali and Varade. 1981) are available. Diffusion of K to the plant is slow with inadequate water supply (Nelson. 1982). The uptake of N. P and K increases due to submergence (Sah and Mikkelsen, 1983; Islam *et al.*, 1986).

Manipulation of planting geometry appears to have a promising potential for increasing the rice yield, as it is assumed to have pronounced effect on tillering, interception and utilisation of light, which in turn influences rice yield (Alexander *et al.*, 1988). However, not much work has been done on the effect of planting geometry and the number of seedlings in conjunction with water management on nutrient availability and uptake. Hence the present study was undertaken.

MATERIALS AND METHODS

Field experiments were conducted during October-January season for two consecutive years (1993-94 and 1994-95) at Agricultural Research Station, Aliyarnagar. The location is geographically situated at 10°39'5"N latitude and 77°0'5"E longitude at an altitude of 260 m above mean sea level. The soil texture of the experimental field was sandy loam, estimating low available nitrogen (230 kg ha^{-1}), medium available phosphorus (12.5 kg^{-1}) and potassium (250 kg ha^{-1}). The pH of the experimental field was 7.3 with bulk density 1.3 g CC^{-1}. Field capacity and permanent wilting point were 20.4 percent and 10.4 percent, respectively. The experimental field was irrigated by well water with pH of 7.9 and EC of 0.6 dSm^{-1}. R.S.C. of irrigation water was 0.1 m eq l^{-1} and S.A.R. value was 2.4. During 1993-94 cropping season. medium duration rice variety IR 20 was the test variety.

The experiments were laid out in split - split plot design with three replications. Irrigation one day (I_1) and two days (I_2) after disappearance water formed the main plot treatments. Sub-plots had 50 hills m⁻² with a spacing of 20 X 10 cm (P_1) and 14.1 X 14.1 cm (P_2) and 33 hills m⁻² with a spacing of 20 X 15 cm (P_3) and 17.4 X 17.4 cm (P_4). Sub-subplots were planted with two (S_1), four (S_2) and six (P_3) seedlings per hill during 1993-94. During 1994-95 the sub-subplot treatments consisted of three rice cultivars viz., IR 20 (V_1), ADT 38 (V_2) and CO 45 (V_3) replacing the previous year treatments. The cultivars were planted at 4 seedlings hill⁻¹, based on previous season results. Gross and net plot size was 4.8m X 4.2m and 4.0m X 3.8m respectively.

After thorough main field preparation, individual plots were laidout with a bund of 25 cm breadth and 15 cm height and with provisions of buffer channel between two bunds. A fertiliser schedule of 150:50:50 kg NPK ha⁻¹ was followed. Rice seedlings were raised in wet nursery and 30 days old seedlings were transplanted as per the treatments. Shallow submergence was maintained for establishment of seeldings till one week after transplanting in all the treatments. Thereafter, irrigation was given to 5 cm depth as per the treatments using a parshall flume of 7.5 cm throat width. Irrigation was stopped 7 days before the harvest of the crop.

For plant analysis, the plant collected for dry matter estimation were chopped and ground into fine powder in a Willey mill and analysed for the total N, P and K contents, and uptake was worked out. After harvest of the crop, soil was analysed for available N, P and K.

RESULTS AND DISCUSSION

Dry matter production (DMP)

At maturity, irrigation regimes affected DMP significantly. Irrigation one day after disappearance of ponded water recorded higher DMP compared to irrigation three days after disappearance of ponded water, obviously indicating a higher requriement of water by rice crop.

Planting methods significantly influenced DMP. During both the years of study, maintaining a population of 50 hills m⁻² recorded significantly higher DMP over 33 hills m⁻². However, at any given population level, method of planting, rectangular

Table 1. Effect of treatments on DMP and nutrient uptake

Treatments	Drymatter production (kg ha⁻¹)		Nitrogen uptake (kg ha⁻¹)		Phosphorus uptake (kg ha⁻¹)		Potassium uptake (kg ha⁻¹)	
	1993	1994	1993	1994	1993	1994	1993	1994
I_1	12748	13950	99.6	113.2	25.2	28.8	117.8	126.9
I_2	12358	13555	95.0	109.5	23.9	27.9	112.9	122.4
SE_d	23	69	0.63	0.67	0.29	0.31	0.71	0.42
CD	101	299	2.72	2.78	1.25	NS	3.04	1.80
P_1	12754	14339	97.8	115.2	24.7	29.0	116.9	129.2
P_2	12742	14311	98.3	114.8	24.7	29.8	115.8	129.2
P_3	12334	13170	96.5	107.4	24.5	26.8	114.6	120.5
P_4	12334	13189	96.7	108.1	24.4	27.6	113.9	120.5
SE_d	74	59	0.85	1.13	0.64	0.41	0.58	0.49
CD	163	128	NS	2.46	NS	0.88	1.26	1.07
S_1	12511	12016	97.1	99.6	24.5	25.6	114.6	111.2
S_2	12738	14680	98.9	116.7	24.9	29.6	117.5	131.2
S_3	12409	14560	95.9	117.9	24.3	29.7	113.9	131.6
SE_d	59	70	0.68	0.96	0.46	0.36	0.39	0.72
CD	121	143	1.38	1.94	NS	0.74	0.79	1.47
Interactions	NS							

or equidistant did not affect the DMP. Though DMP recorded in individual plant (hill) was higher at wider spacing, due to the presence of lesser number of hills unit area^{-1}, the DMP ha^{-1} was lower at wider planting.

With respect to number of seedlings planted hill^{-1}, 4 seedlings recorded significantly higher DMP over 2 seedlings and 6 seedlings hill^{-1}, which did not differ significantly between themselves.

Rice varieties CO 45 and ADT 38 recorded higher DMP compared to IR 20 owing to their difference in genetic potential.

Nutrient Uptake

Irrigation regimes significantly influenced nitrogen uptake. Irrigation one day after disappearance of ponded water (I_1) recorded higher uptake than irrigation three days after disapperance of water (I_2)in both the years of study. The N availability would have been more under I_1 due to lesser loss of ammonia through volatalisation. Increased avaiable N and the demand by expanding shoot might have resulted in increased uptake under I_1. Singandhupe and Rajput (1990) also reported reduction in the uptake of N with increasing interval between irrigation. P uptake was influenced significantly only during 1993 while K uptake was influenced in both the years. I_1 recorded significantly higher uptake than I_2. The results of the present study are in conformity with the findings of Pandey *et al.* (1992).

Planting geometry influenced the nitrogen and phosphorus uptake significantly in 1994 only, while the K uptake was influenced in both the years of study. Higher nutrient uptake was recorded under the population level of 50 hills m^{-2}, which could be attributed to higher biomass production under closer planting. In both the population levels, the method of planting, whether rectangular or equidistant did not significantly after the nutrient uptake.

With reference to number of seedling hill^{-1}, 4 seedlings hill^{-1} (S_2) registered higher nitrogen uptake, followed by 2 (S_1) and 6 seedlings hill^{-1} (S_3). All the three varied significantly among themselves. Number of seedlings hill^{-1} failed to influence P uptake significantly. K uptake was

Table 2. Effect of treatments on soil available nutrients (kg ha^{-1}) and grain yield (kg ha^{-1})

Treatments	Soil available nitrogen (kg ha^{-1})		Soil available phosphorus (kg ha^{-1})		Soil available potassium (kg ha^{-1})		Grain yield (kg ha^{-1})	
	1993	1994	1993	1994	1993	1994	1993	1994
I_1	217	213	12.01	12.18	233	228	5704	6289
I_2	222	208	12.72	12.68	245	233	5513	6085
SE_d	2.4	1.3	0.13	0.21	4.1	2.9	26	41
CD	NS	NS	0.55	NS	NS	NS	112	177
P_1	218	208	12.17	12.08	228	228	5660	6246
P_2	218	206	12.36	12.39	242	227	5632	6218
P_3	223	215	12.58	12.83	243	236	5588	6158
P_4	220	212	12.36	12.42	242	232	5556	6127
SE_d	2.5	4.4	0.11	0.15	8.9	1.5	49	50
CD	NS	NS	0.24	0.32	NS	3.4	NS	NS
S_1	221	217	12.48	13.29	233	238	5586	5875
S_2	217	209	12.02	12.02	240	228	5685	6331
S_3	221	206	12.60	11.98	243	226	5555	6355
SE_d	3.41	3.1	0.10	0.17	7.7	1.8	30	41
CD	NS	6.30	0.20	0.35	NS	3.7	62	84
Interactions	NS							

significantly higher in S_2 compared to S_1 and S_3, which did not differ between themselves.

Higher N, P and K uptake was recorded in CO 45 and ADT 38 compared to IR 20. Nutrient uptake did not differ significantly between CO 45 and ADT 38. The difference in nutrient uptake is a varietal charater which has also been obe\served earlier by Chandragiri (1988).

Soil available nutrients

Irrigation regimes did not affect the soil available N and K, but only influenced soil available P. The P status was higer with irrigation three days after disappearance of water, possibly due to reduced P loss through water outlet and low solubility under this irrigation regime. Most of P input might be incorporated in the sediments probably both by adsorption by clay particles and by precipitation as hydroxy apatite. Muthukrishnan (1990) reported similar finding.

Planting geometry influenced only the soil available P while soil available N was not influenced. Soil available K was influenced only in 1994 and followed the same trend as soil available P, which was higher under wider planting of 33 hills m^{-2} compared to 50 hills m^{-2}. This could be attributed to lesser P uptake of phosphorus noticed under wider planting and comparatively lesser loss of this nutrient from the soil which resulted in increased soil available P.

Number of seedlings $hill^{-1}$ did not influence the soil available nutrients except P. Soil available P was higher in planting 2 or 6 seedlings $hill^{-1}$ compared to 4 seedlings $hill^{-1}$ (S_2). Higher uptake of P under planting S_2 could be the reason for reduced soil P recorded in this treatment. Soil available N, P and K was higher when IR 20 was raised compared to CO 45 and ADT 38, probably owing to reduced uptake by IR 20.

Grain Yield

Irrigation one day after disapperance of ponded water recorded higher grain yield compared to irrigation three days after disapperance of ponded water. It is possible that enhanced nutrient availability under the high irrigation regime promoted the supply of assimilates to 'sink' thus resulting in more number of spikelets leading increased yield. Planting 4 seedlings $hill^{-1}$ recorded higher grain yield compared to planting 2 or 6 seedlings $hill^{-1}$. CO 45 and ADT 38 recorded higher grain yield compared to IR 20.

Field water requirement

Data on the quantity of water applied, effectiv rainfall and total water used in 1994 and 1995 ar presented in Table 3.

Results showed that irrigation one day afte disappearance of water (I_1) consumed more wate than irrigation three days after disappearance wate. (I_2). Field water requirement of IR 20 was 1032 mm and 1088 in I_1 and 932 and 988 mm under I_2 during 1994 and 1995 respectively. Field water requirement of ADT 38 and CO 45 was higher compared to IR 20. Water requirement of ADT 38 and CO 45 in I_1 irrigation regime was 1138 mm compared to 1038 mm in I_2. Delay in submergence (I_2) resulted in considerable water saving. In IR 20, the water saving in I_2 compared to I_1 was 10.7 percent during

Table 3. Field water requirement (mm)

	1993-94			1994-95					
	Water applied	Effective rainfall	Total water used	Water applied IR 20	Water applied ADT38 & CO45	Effective rainfall IR 20	Effective rainfall ADT38 & CO45	Total water used IR 20	Total water used ADT38 & CO45
(irrigation one day after disappearance of water)	750	282	1032	700	750	388	388	1088	1138
(irrigation three days after disappearance of water)	650	282	932	600	650	388	388	988	1038

1994 and 10.1 percent in 1995. Water saving in ADT 38 and CO 45 due to adoption of I_2 irrigation level compared to I_1 was 9.6 percent.

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ALTERNATE CROPPING SYSTEM FOR SINGLE RICE BASED LOWLANDS OF KARAIKAL REGION OF UNION TERRITORY OF PONDICHERRY

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ABSTRACT

Field experiments were conducted during 1993-95 at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal for evolving alternate cropping systems for the Karaikal region of Union Territory of Pondicherry, which is situated at the tail end of Cauvery delta zone. Rice-cotton system was found to be the best system since it outyielded the conventional system (rice-blackgram)) and other cropping systems evaluated (rice-soybean, rice-vegetable cowpea and rice-sesame). The system rice-cotton recorded the maximum gross and net returns followed by rice-vegetable cowpea system. The rice-cotton system may be adopted in areas where water is available for atleast ten irrigations during summer and in areas where water is available for only five irrigations rice-vegetable cowpea system may be economical. Among the four levels of N (o,75, 112.5 or 150 Kg ha^{-1}) applied to rice, application of 150 Kg N ha^{-1} increased not only the yield of rice but also the production potential of the system in all the cropping systems studied.

KEY WORDS : Rice based system, Alternative system

Rice is the principal food crop cultivated in the lowlands of Karaikal region which is situated in the tail end of Cauvery delta. With augmented and controlled supplies of water from Mettur reservoir, rice is cultivated during three different seasons in a year *viz.*, kuruvai (June-July to