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Effect of Irrigation Regimes, mid season drainage and time of Application of Nitrogen on Hybrid Rice

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Abstract : Field experiments were conducted during kharif seasons of 1999-2000 and 20002001 to study the effect of irrigation, drainage and nitrogen management on CoRH 2 Hybrid rice at Agricultural college and Research Institute, Madurai. The results revealed that irrigation to 5cm depth one day after disappearance of ponded water with mid season drainage and application of N in four splits viz., 16.7% at 10 DAT, 33.3% at AT, 33.3`% at PI and 16.7% at Heading registered the higher growth attributes, yield attributes, grain yields, WUE and economics. The above treatment combinations registered the maximum grain yield of 7533 and 8078 kg ha -1 during 1999-2000 and 20002001 respectively.

Key words : Hybrid rice, irrigation, WUE, drainage, economic analysis, and nitrogen.

Introduction

Rice is the staple food crop of densely populated Asian countries and is being cultivated under varied ecosystems. India had produced 112 Million tonnes of rice from 41.8 million hectare with a productivity of 2,691 kg ha^{-1} (Kannaiyan, 2000). In traditional method of cultivation, farmers resort to continuous submergence, resulting in enormous wastage of water and lower water use efficiency. Hence rice production consumes major share of water. Irrigation efficiencies seem to be the practical way to "save water". Hence, it becomes essential to develop and adopt strategies and practice for more efficient use water in rice cultivation. One such techniques for increasing water use efficiency in rice cultivation is Alternate Wet Dry Irrigation (AWDI) method viz., irrigation to submergence to a particular depth after disappearance of ponded water in which rice fields are not kept continuously submerged but are allowed to dry intermittently during the rice growing stages. The beneficial effect of this irrigation practice is water saving and yield improvement in rice varieties. Hence, the present study was taken up to find out the effect of irrigation schedule, drainage and split application of N on medium duration hybrid rice.

Materials and methods

The field experiments were conducted during 1999-2000 and 2000-2001 at Agricultural College and Research Institute, Madurai on sandy clay loam soil having low available N (156.4 kg ha^{-1}), medium available P (12.5 kg ha^{-1}) and high available K (251.6 kg ha^{-1}) with neutral in reaction (pH 7.3). The experiment was laid out in a split plot design with three replications. Hybrid rice CoRH 2(125-130 days duration) was used for the study. The six different irrigation schedules tested in the main plot, were I_1: farmers method of irrigation (continuous submergence to 5cm depth), I_2: Irrigation to 5cm depth one day after disappearance of ponded water, I_3: Irrigation to 5cm depth three days after disappearance of ponded water, I_4: I_1 + mid season drainage, I_5: I_2 + mid season drainage and I_6: I_3 + mid season drainage. The mid season drainage with waterless period of 4-7 days was maintained at

maximum 40-50 DAS. The sub plots comprised of four different times of N application viz., N_1: Three splits as 33.3% each at 10 DAT, AT and PI, N_2: Four splits as 16.7% at 10 DAT, 33.3% at AT, 33.3% at PI and 16.7% at H, N_3: Four splits as 25% each at 10 DAT, AT PI and H, N_4: Five splits as 20% each at 10 DAT, AT, MT, PI and at H stages.

Recommended does of fertilizers (150:50:50 N, P_2O_5 and K_2O kg ha^{-1}) were applied as urea, single super phosphate and muriate of potash. Planting was done with a spacing of 20 x 10 cm at the rate of single seedling $hill^{-1}$. The other cultivation practices were followed as per the recommendation given in the crop production guide. Five plants in the net plot area were tagged and biometric observations were recorded from these plants at different stages.

Results and Discussion

Growth Attributes

The results of the experiment revealed that the growth attributes viz., plant height, leaf area index and dry matter production were significantly influenced by both irrigation and N management practices (Table 1). The plant height at harvest under irrigation to 5cm depth one day after disappearance of ponded water in combination with mid season drainage was 102.25 and 109.40 cm and was higher than other irrigation treatments. The increased plant height observed for this treatment was due to favorable root growth and higher mobility of N in soil solution and its absorption by plant roots and consequently resulting higher plant height. The LAI and DMP recorded were higher under irrigation to 5cm depth one day after disappearance of ponded

Table 1. Effect of irrigation schedule and time of application of N on growth characters (harvest)

Treatment	Plant height (cm)		LAI		DMP (ka ha^{-1})	
	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000 2001
Main plot Irrigation Schedule						
I_1	94.85	101.48	4.53	4.84	14980	16028
I_2	96.91	103.69	4.77	5.10	15000	16050
I_3	93.25	99.77	4.34	4.64	14979	16028
I_4	99.75	106.73	5.21	5.57	15168	16230
I_5	102.25	109.40	5.68	6.07	15350	16424
I_6	90.83	97.18	4.19	4.48	14125	15114
SEd	0.318	0.340	0.02	0.02	249	266
CD (p=0.05)	0.709	0.758	0.03	0.04	555	594
Sub plot N split						
N_1	95.18	101.18	4.68	5.00	14587	15769
N_2	97.22	104.20	4.87	5.20	15256	16215
N_3	96.45	103.60	4.85	5.19	15-086	16119
N_4	96.37	103.37	4.74	5.07	14807	15812
SEd	0.44	0.45	0.03	0.03	67	72
CD (p=0.05)	0.86	0.92	0.05	0.05	136	146

water in combination with mid season drainage treatment. The increase in LAI might have been brought up by increased plant height. Better aeration in the form of mid season drainage might have resulted in favourable root growth and absorption of nutrients. This is in agreement with the findings of Raju *et al.* (1993) and Chandrasekaran (1996).

Application on N in four splits viz., (N_2 and N_3) 16.7% at 10 DAT, 33.3% at AT, 33.3% at PI and 16.7% at H or 25% each at 10 DAT, AT, PI and H proved better and thus increased the plant height and LAI. The increase in growth characters was mainly due to better absorption and utilization of N as observed from higher uptake under these treatments. The increase in these growth characters consequently resulted in higher DMP obtained with this treatment. Beneficial effects of four splits made at 10 DAT, AT, PI and H was also reported by Palanimurugesan (1997).

Yield attributes

The results of the experiment revealed that the yield attributes were significantly influenced by both irrigation and N management practices (Table 2). The irrigation practice of submergence to 5 cm depth one day after disappearance of ponded water with mid season drainage (I_5) registered maximum number of panicle per hill (13.00 and 14.05), panicle length (29.00 and 31.03 cm), panicle weight (4.02 and 4.30g), number of grains per panicle (114 and 122) and, test weight (22.49 and 24.19g) during both years. This might be due to better aeration and root system associated with higher mobility and absorption of inorganic N in soil solution which increased the uptake of nutrient and contributed to favourable growth attributes which in turn had resulted on higher yield attributes. This is in agreement with the findings of Palchamy *et al.* (1989).

Fractional application of N extending upto heading was beneficial. The N2 treatment did record more number of panicles $hill^{-1}$ (11.08 and 12.06), panicle length (24.09 and 25.70 cm), panicle weight (3.33 and 3.56), number of grains per panicle (101 and 108) and test weight (22.42 and 24.10g) during both the years of experimentation. Synchronized N uptake with the crop demand under this treatment might have led to translocation of carbohydrates to sink and consequently resulted on favourable growth which reflected in increased yield attributes. Similar findings were reported by Palanimurugesan (1997).

Grain Yield

The maximum grain yield 7064 and 7558 kg ha^{-1} (Table 3) was obtained due to the judicious combination of irrigation to five cm depth one day after disappearance of ponded water with mid season drainage (I_5). Mid season drainage might have arrested the growth of late tillers and ultimately resulted in efficient conversion of tillers to panicles. The percentage of tillers is higher (18.63%) than farmer's method of irrigation. The yield improvement due to better drainage is 16.87% than farmer's method of irrigation. The favourable growth with higher nutrient uptake along with increased yield attributes resulted in producing higher grain yield. A similar finding was reported by Ramamoorthy *et al.*, (1993). The advantage of providing mid season drainage at maximum tillering on grain yield was observed by Ghosh and Das (1999).

The grain yield of hybrid rice was greatly influenced by the split application of N. Application of N in four splits viz., 16.7% at 10 DAT, 33.3% at AT, 33.3% at PI and 16.7% at H (N_2) or balanced application of 25% each at 10 DAT, PI and H (N_3) recorded higher rice grain yield and were comparable with each other. The percentage of increase under N_2 is 17.88 and 15.65 per cent over three splits (N_1) during 1999-2000 and 2000-2001, respectively. Increased yields under four split might by due to increased uptake of nutrients coupled with

Table 2. Effect of irrigation schedule and time of application of N on yield attributes

Treatment	Number of Panicles hill^{-1}		Panicle Length (cm)		Panicle Weight (g)		Number of grains per panicle		Test Weight (g)		Uptake of N at harvest stage (Kg/ha)	
	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-12001	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000 2001
Main plot Irrigation schedule												
I_1	9.75	10.57	21.99	23.52	3.02	3.23	94	101	21.60	23.25	98.37	105.25
I_2	11.00	11.91	23.75	25.41	3.25	3.47	100	107	21.97	23.64	101.67	108.87
I_3	9.00	9.77	20.75	22.20	2.83	3.02	89	95	21.13	22.74	96.72	103.49
I_4	12.09	13.07	26.00	27.82	3.61	3.86	108	115	22.14	23.82	104.32	111.62
I_5	13.00	14.05	29.00	31.03	4.02	4.30	114	122	22.49	24.19	107.97	115.52
I_6	7.25	7.89	19.00	20.33	2.63	2.81	84	90	20.59	22.17	94.77	101.48
SEd	0.49	0.52	0.52	0.55	0.01	0.01	2.31	2.47	0.13	0.13	0.208	0.222
CD =(p=0.05)	1.10	1.18	1.14	1.21	0.02	0.02	5.15	5.51	0.28	0.29	0.464	0.496
Sub plot N split												
Nl	9.23	10.01	22.50	24.07	3.11	3.32	96	102	20.76	22.35	99.75	106.73
N2	11.08	12.06	24.09	25.70	3.33	3.56	101	108	22.42	24.10	101.60	108.71
N3	10.92	11.85	23.89	25.63	3.27	3.49	99	107	21.31	24.03	100.88	107.94
N4	10.17	11.02	23.17	24.71	3.19	3.41	97	106	21.31	22.71	100.33	107.35
SEd	0.14	0.15	0.09	0.09	0.03	0.03	0.04	0.04	0.24	0.25	0.348	0.372
CD =0.05	0.29	0.31	0.20	0.21	0.07	0.07	0.08	0.09	0.48	0.51	0.767	0.820

Table 3. Effect of irrigation schedule and time of application of N on grain yield (Kg ha^{-1})

Split application of N	Irrigation schedule													
	1999-2000							2000-2001						
	I_1	I_2	I_3	I_4	I_5	I_6	Mean	I_1	I_2	I_3	I_4	I_5	I_6	Mean
N_1	5176	5851	5329	6321	0382	5160	5703	5538	6260	5702	6763	6829	5521	6102
N_2	6520	6861	6347	7112	7533	6100	6775	6993	7358	6755	7628	8078	6725	7235
N_3	6478	6664	6294	7199	7440	6301	6689	6914	7113	6717	7685	7943	6545	7183
N_4	6003	6096	5873	6423	6900	5643	6156	6424	6522	6284	6873	7383	6038	6587
Mean	6044	6368	5961	6773	7064	5776		6467	6814	6378	7236	7558	6207	

Treatments	1999-2000		2000-2001	
I	160	356	171	380
N	49	99	48	106
I_{at} N	190	413	204	442
N_{at} I	120	243	128	260

favourable growth and yield attributes. Similar findings were expressed by Palanimurugesan (1997) and Sivakami (2000) also.

Interaction was found to exist between irrigation practice and N splits in respect of rice grain yields. At -all levels of N, irrigation to five-centimeter depth one day after disappearance of ponded water with mid season drainage registered higher grain yields of rice. Similarly at all levels of irrigation, N_2 registered higher grain yields of hybrid rice. In combination also these two treatments produced higher grain yields followed by I_5 N_3.

Water use efficiency

The higher water use efficiency of 7.47 and 7.83 Kg ha^{-1} mm^{-1} was observed during 1999-2000 and 2000-2001 respectively under the irrigation treatment of irrigation to 5cm depth one day after disappearance of ponded water practiced in combination with mid season drainage (Table 4). In terms of percentage, increase in water use efficiency under this treatment compared to the farmer's practice of continuous submergence was 50 and 53 percent during 1999-2000 and 2000-2001 respectively. The increased water use efficiency obtained for this treatment could be attributed to optimum consumptive water use coupled with increased grain yield levels. The higher. consumptive use with more frequent irrigation without corresponding increase in grain yields could have led to decreased WUE under continuous submergence treatment. This was found to be in agreement with the findings of Ramamoorthy *et al.* (1993).

Among the treatments on time of application of N, four splits viz., 16.7% at 10 DAT, 33.3% at PI and 16.7% at H (N_2) stages registered higher WUE followed by N_3. The increased rice grain yields observed under these treatments might be the reason for registering higher WUE.

Economics

Net returns revealed that, during both the years, for irrigation practices, irrigation to 5 cm depth one day after disappearance of ponded water with mid season drainage and for N splits, four time of application accounted for producing higher net returns (Table 4). The values were Rs.32,623 and Rs.35,997 ha^{-1} during 1999-2000 and 2000-2001 respectively. This may be due to higher economic yields observed in these combinations. The farmers' practice of continuous submergence of irrigation and application of N in three splits resulted in getting lesser net returns (Rs.17,519 and Rs.19,795). This is in agreement with the findings of Manimaran (1993). The benefit cost ratio also followed the same trend as that of net returns.

From the two years of study, it could be inferred that, for medium duration hybrid rice CoRH 2, irrigation to 5 cm one day after disappearance of ponded water and provided with mid-season drainage at maximum tillering stage is the best irrigation management practice for, obtaining favourable growth, yield attributes, grain yields, WUE and economic returns. Similarly application of N, in four splits viz., 16.7% at 10 DAT, 33.3% AI, 33.3% PI and 16.7% at H or 25% each atl0 DAT, AT, PI and H was found to be better N management practice for getting higher growth, yield

Table 4. Effect of irrigation schedule and time of application of N on WUE, net return and B:C ratio

Treatment	WUE (Kg ha^{-1} mm^{-1})		Net return (Rs/ha)		B:C ratio	
	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000 2001
Main plot Irrigation Schedule						
I_1	4.95	5.12	22085	24846	2.45	2.64
I_2	6.40	6.71	24877	27622	2.72	2.92
I_3	6.66	6.95	23148	25658	2.69	2.89
I_4	5.78	5.95	26613	29518	2.81	2.98
I_5	7.47	7.83	29288	32599	3.05	3.30
I_6	6.86	7.17	24338	24351	2.78	2.81
SEd	0.26	0.29	-	-	-	-
CD (p=0.05)	0.58	0.64	-	-	-	-
Sub plot Time of application of N						
N_1	5.72	5.97	21331	20186	2.49	2.67
N_2	6.77	7.10	28237	30525	2.98	3.14
N_3	6.75	6.97	27064	29530	2.89	3.07
N_4	6.18	6.45	23601	25859	2.64	2.80
SEd	0.24	0.30	-	-	-	-
CD (p=0.05)	0.50	0.62	-	-	-	-

* Interaction not significant *Data statistically not analyzed

attributes, grain yields, WUE and economic returns in medium duration hybrid rice.

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