

STRESS WATER MANAGEMENT IN SEMI-DRY RICE

N. ASOKARAJA

WTC, TNAU, Coimbatore - 641 003.

ABSTRACT

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during 1994-95 and 1995-96 to study the influence of water stress and seed hardening and foliar sprays for mitigating the stress at early vegetative phase of semi-dry rice. The study revealed that irrigation to semi-dry rice at 5 cm depth at weekly intervals upto 45 and 60 Days after emergence (DAE) were significantly superior to fortnightly irrigations. Seed hardening with Chamatkar 125 ppm with foliar spray of KCl 0.5% had significant favourable influence to mitigate the stress in the early vegetative phases of semi-dry rice.

KEY WORDS: Semi-dry rice, Irrigation, Seed hardening, Foliar spray, Moisture stress

Rice is grown in an area of 41 million ha with a production of about 74 million tonnes in India. Tamil Nadu cultivates rice in 2.7 million ha with a production of 5.6 million tonnes. Direct seeding of rice is practised in Chengai-MGR, Tanjore, Ramanathapuram, Pudukkottai and Kanyakumari districts, where irrigation is through mostly non-system tanks. There is uncertainty in the release of water invariably in all tank commands due to poor storage in tanks consequent to inadequate rainfall. This situation creates enormous changes in early growth phases of semi-dry rice. Ground water could be a supplemental source for irrigation upto 45-60 days after sowing. Hence a study was taken up to determine the optimum irrigation scheduling and the effect of seed hardening cum foliar spray techniques on the yield and water requirement of semi-dry rice.

MATERIALS AND METHODS

The field experiments were carried out during 1994-95 and 1995-96 (July-Oct.) at 'C' Block of wetlands at Tamil Nadu Agricultural University, Coimbatore. Four irrigation scheduling viz., irrigation at weekly intervals upto 45 DAE (I1) and upto 60 DAE (K₂O) and fortnightly irrigations upto 45 DAE (I₂) and upto 60 DAE (I4) in main plots and four seed hardening treatments viz., seed hardening with Chamatkar (mepiquat chloride 5 AS) at 125 ppm (S2), S2 + foliar spray of KCl 0.5% (S3), foliar spray of KCl 0.5% alone (S4) seed soaking with water (S5) along with control (S1) in sub-plots were imposed, replicated thrice in split plot design. Seeds were broadcasted and irrigation was done

with 40 mm of water on the day of seeding and on third day to all the treatments. Subsequent irrigations were given at a depth 50 mm of water to weekly wetting and fortnightly wetting treatments upto the duration of stress. Irrigations were replenished to 5 cm depth after complete infiltratin of ponded water upto 10 days prior to harvest. The rice was post flooded after imposing treatments upto 45 & 60 DAE as per treatments schedules. Seeds were hardened by soaking either with Chamatkar at 125 ppm or water for 18 hours followed by incubation at room temperature and dried at ambient temperature to original weight. Foliar spray of KCl at 0.5% was done two times at 45 and 60 days after seeding. Rice variety ADT.36 was used as a test crop. The crops were raised during July to Oct. in both years. A total effective rainfall of 185 and 317 mm was received during 1st and II year respectively.

The soil of the experimental field was clay loam with pH : 6.5 ; field capacity : 23.5 per cent ; wilting point : 11.5 per cent and a bulk density of 1.35 g/cc. Basally half dose of N (urea) and full dose of P205 (Super phosphate) and half dose of K₂O (Muriate of potash) were applied. The remaining N and K₂O were top dressed in two equal splits at maximum tillering and panicle initiation stages.

RESULTS AND DISCUSSION

Growth Attributes

Among irrigation treatments, irrigation at weekly intervals upto 45 DAE (I1) recorded

Table 1. Effect of treatments on growth and yield characters in semi-dry rice (ADT 36)

Treatments	Plant height (cm)		No. of tillers/m ²		No. of panicles/m ²		No. of filled grain/panicle		Test grain weight (g)	
	I yr	II yr	I yr	II yr	I yr	II yr	I yr	II yr	I yr	II yr
I₁ Weekly irrigation upto 45 DAE										
S ₁ - Control - no seed hardening, no foliar spray	66.24	66.90	276.0	284.3	256.0	258.7	78	83	20.14	20.25
S ₂ - Seed hardening - chamatkar 125 ppm alone	68.92	69.63	282.0	290.3	262.3	265.0	85	89	20.67	20.78
S ₃ - S ₂ + foliar spray KCl 0.5%	71.44	72.13	302.0	311.0	289.3	292.7	89	94	20.77	20.87
S ₄ - No seed hardening + foliar spray KCl 0.5%	70.26	70.97	289.3	298.0	270.0	272.7	87	91	20.72	20.83
S ₅ - Seed soaking with water	67.26	68.07	280.3	289.3	210.3	212.3	81	86	20.32	20.41
I₂ Fortnightly irrigation upto 45 DAE										
S ₁ - Control - no seed hardening, no foliar spray	64.34	64.97	256.3	264.0	235.3	237.7	75	80	20.10	20.20
S ₂ - Seed hardening - chamatkar 125 ppm alone	66.28	66.97	265.3	273.3	247.3	249.7	80	84	26.62	20.72
S ₃ - S ₂ + foliar spray KCl 0.5%	69.67	70.37	282.3	290.7	256.7	259.0	85	90	20.74	20.84
S ₄ - No seed hardening + foliar spray KCl 0.5%	68.46	69.17	270.7	278.7	254.3	257.0	82	86	20.71	20.80
S ₅ - Seed soaking with water	65.22	65.90	260.3	268.0	241.3	243.7	79	84	20.20	20.30
I₃ Weekly irrigation upto 60 DAE										
S ₁ - Control - no seed hardening, no foliar spray	66.12	66.80	274.3	282.7	254.3	257.0	76	80	20.12	20.22
S ₂ - Seed hardening - chamatkar 125 ppm alone	68.76	69.47	280.7	289.0	261.3	264.0	82	87	20.65	20.76
S ₃ - S ₂ + foliar spray KCl 0.5%	71.22	71.93	300.7	309.7	288.7	291.7	86	90	20.76	20.86
S ₄ - No seed hardening + foliar spray KCl 0.5%	70.12	70.83	290.0	298.7	269.3	272.0	85	90	20.71	20.82
S ₅ - Seed soaking with water	67.04	67.70	278.3	286.7	259.7	262.3	80	84	20.25	20.34
I₄ Fortnightly irrigation upto 60 DAE										
S ₁ - Control - no seed hardening, no foliar spray	64.12	64.77	258.3	266.0	234.7	237.0	72	77	20.10	20.21
S ₂ - Seed hardening - chamatkar 125 ppm alone	66.12	66.80	262.3	270.3	246.3	248.7	79	83	20.57	20.67
S ₃ - S ₂ + foliar spray KCl 0.5%	69.14	69.83	280.3	288.7	262.3	265.0	82	87	20.70	20.81
S ₄ - No seed hardening + foliar spray KCl 0.5%	68.92	69.63	270.3	278.3	251.3	254.0	80	85	20.68	20.78
S ₅ - Seed soaking with water	65.04	65.73	260.3	268.0	240.7	243.0	76	80	20.20	20.29
Mean										
I ₁	68.83	69.54	285.9	294.6	257.6	260.3	84	89	20.52	20.63
I ₂	66.80	67.43	267.0	274.9	247.0	249.4	80	85	20.47	20.58
I ₃	68.66	69.35	284.8	293.3	266.7	269.4	82	86	20.50	20.60
I ₄	66.67	67.35	266.3	274.3	247.1	249.5	78	82	20.45	20.55
S ₁	65.21	65.86	266.3	274.3	245.1	247.6	75	80	20.12	20.22
S ₂	67.53	68.22	272.6	280.8	254.3	256.8	82	86	20.63	20.73
S ₃	70.37	71.07	291.3	300.0	274.3	277.1	86	90	20.74	20.85
S ₄	69.45	70.15	280.1	288.4	261.3	263.9	84	88	20.71	20.81
S ₅	66.14	66.85	269.8	278.0	238.0	240.3	79	84	20.24	20.34
I	1.84	0.53	2.92	2.08	3.81	2.00	2.7	2.1	0.05	0.04
S	1.43	1.32	4.18	2.09	4.04	3.62	2.7	2.2	0.03	0.03
S at I	2.85	NS	NS	NS	8.09	7.25	NS	NS	NS	NS
I at S	3.13	NS	NS	NS	8.16	6.78	NS	NS	NS	NS

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Table 2. Effect of irrigation scheduling and seed hardening on the yield in semi dry rice (ADT 36)

		Grain yield (kg/ha)		Straw yield (kg/ha)	
		I yr	II yr	I yr	II yr
I₁ Weekly irrigation upto 45 DAE					
S ₁	- Control - no seed hardening, no foliar spray	3920	4450	4914	5563
S ₂	- Seed hardening - chatmatkar 125 ppm alone	4784	5382	5959	6730
S ₃	- S ₂ + foliar spray KCl 0.5%	5206	5750	6523	7188
S ₄	- No seed hardening + foliar spray KCl 0.5%	4960	5385	6182	6731
S ₅	- Seed soaking with water	4600	5145	5742	6468
I₂ Fortnightly irrigation upto 45 DAE					
S ₁	- Control - no seed hardening, no foliar spray	3342	3857	4185	4822
S ₂	- Seed hardening - chatmatkar 125 ppm alone	3760	4225	4678	5284
S ₃	- S ₂ + foliar spray KCl 0.5%	4464	5057	5577	6324
S ₄	- No seed hardening + foliar spray KCl 0.5%	4206	4740	5243	5930
S ₅	- Seed soaking with water	3860	4265	4818	5332
I₃ Weekly irrigation upto 60 DAE					
S ₁	- Control - no seed hardening, no foliar spray	3860	4212	4848	5267
S ₂	- Seed hardening - chatmatkar 125 ppm alone	4654	5162	5780	6453
S ₃	- S ₂ + foliar spray KCl 0.5%	5012	5604	6270	7005
S ₄	- No seed hardening + foliar spray KCl 0.5%	4874	5325	6106	6657
S ₅	- Seed soaking with water	4562	4947	5689	6180
I₄ Fortnightly irrigation upto 60 DAE					
S ₁	- Control - no seed hardening, no foliar spray	3154	3685	4008	4610
S ₂	- Seed hardening - chatmatkar 125 ppm alone	3562	4074	4452	5094
S ₃	- S ₂ + foliar spray KCl 0.5%	4380	4890	5598	6113
S ₄	- No seed hardening + foliar spray KCl 0.5%	4187	4640	5230	5805
S ₅	- Seed soaking with water	3763	4215	4733	5269
Mean	I ₁	4694	5222	5864	6536
	I ₂	3926	4429	4900	5538
	I ₃	4592	5050	5739	6312
	I ₄	3809	4301	4804	5378
	S ₁	3569	4051	4489	5066
	S ₂	4190	4711	5217	4890
	S ₃	4766	5325	5992	6658
	S ₄	4557	5022	5690	6281
	S ₅	4196	4643	5246	5812
CD	I	245	57	309	84
	S	224	81	280	78
	S at I	NS	163	NS	156
	I at S	NS	156	NS	163

significantly higher plant height and number of tillers/m² in both years as compared to other irrigation levels (Table .1). Irrigation scheduling at fortnightly intervals upto 45 DAE (I₂) and 60 DAE

(I₄) recorded lower plant height and tillers. In case of seed hardening treatments, seed hardening with chatmatkar 125 ppm + foliar spray of KCl 0.5% (S₃) has recorded higher plant height and number of

Table 3. Effect of irrigation scheduling and seed hardening on the yield and water use in semi-dry rice (ADT.36)

Treatments	Irrigation requirement (mm)		Effective rainfall (mm)		Water requirement (mm)		Grain yield (kg/ha)		Water use efficiency (kg/ha.mm)		
	I yr	II yr	I yr	II yr	I yr	II yr	I yr	II yr	I yr	II yr	
I₁ Weekly irrigation upto 45 DAE											
S ₁ - Control - no seed hardening, no foliar spray	1000	850	185	317	1185	1167	3920	4450	3.31	3.81	
S ₂ - Seed hardening - chatmatkar 125 ppm alone	1000	850	185	317	1185	1167	4784	5382	4.04	4.61	
S ₃ - S ₂ + foliar spray KCl 0.5%	1000	850	185	317	1185	1167	5206	5750	4.39	4.93	
S ₄ - No seed hardening + foliar spray KCl 0.5%	1000	850	185	317	1185	1167	4960	5385	4.17	4.61	
S ₅ - Seed soaking with water	1000	850	185	317	1185	1167	4600	5145	3.88	4.41	
I₂ Fortnightly irrigation upto 45 DAE											
S ₁ - Control - no seed hardening, no foliar spray	955	800	185	317	1140	1117	3342	3857	2.93	3.45	
S ₂ - Seed hardening - chatmatkar 125 ppm alone	955	800	185	317	1140	1117	3760	4225	3.30	3.78	
S ₃ - S ₂ + foliar spray KCl 0.5%	955	800	185	317	1140	1117	4464	5057	3.92	4.53	
S ₄ - No seed hardening + foliar spray KCl 0.5%	955	800	185	317	1140	1117	4206	4740	3.69	4.24	
S ₅ - Seed soaking with water	955	800	185	317	1140	1117	3860	4265	3.39	3.82	
I₃ Weekly irrigation upto 60 DAE											
S ₁ - Control - no seed hardening, no foliar spray	900	750	185	317	1085	1067	3860	4212	3.56	3.95	
S ₂ - Seed hardening - chatmatkar 125 ppm alone	900	750	185	317	1085	1067	4654	5162	4.29	4.83	
S ₃ - S ₂ + foliar spray KCl 0.5%	900	750	185	317	1085	1067	5012	5604	4.62	5.25	
S ₄ - No seed hardening + foliar spray KCl 0.5%	900	750	185	317	1085	1067	4874	5325	4.49	4.99	
S ₅ - Seed soaking with water	900	750	185	317	1085	1067	4562	4947	4.20	4.64	
I₄ Fortnightly irrigation upto 60 DAE											
S ₁ - Control - no seed hardening, no foliar spray	855	700	185	317	1040	1017	3154	3685	3.03	3.62	
S ₂ - Seed hardening - chatmatkar 125 ppm alone	855	700	185	317	1040	1017	3562	4074	3.43	4.01	
S ₃ - S ₂ + foliar spray KCl 0.5%	855	700	185	317	1040	1017	4380	4890	4.21	4.81	
S ₄ - No seed hardening + foliar spray KCl 0.5%	855	700	185	317	1040	1017	4187	4640	4.03	4.56	
S ₅ - Seed soaking with water	855	700	185	317	1040	1017	3763	4215	3.62	4.14	

tillers/m² as compared to other treatments in both years.

Yield Attributes

The number of panicles/m² were higher in weekly irrigations upto 60 DAE (I₃) followed by 45 DAE (II) (Table 1). There was no marked influence of irrigation scheduling on panicle length though there were numerical higher values. With reference to number of filled grains per panicle, irrigation scheduling at weekly intervals upto 45 DAE (II), recorded significantly higher values as compared to other irrigation treatments in both years. Seed hardening with Chamatkar 125 ppm + KCl 0.5% foliar spray (S3) recorded significantly higher number of panicles/m² followed by foliar spray of KCl 0.5% alone (S4) in both years. Test grain weight also followed similar trends.

Grain yields

In respect of irrigation regimes, weekly irrigation upto 45 DAE (II), has registered significantly higher grain yield of 4694 kg/ha in Ist year and 5222 kg/ha in II year (Table 2). This was followed by weekly irrigations upto 60 DAE (I₃) with 4592 kg/ha and 5050 kg/ha in corresponding years. Irrigation at fortnightly intervals upto 45 and 60 DAE (I₂ and I₄) has recorded lower grain yields in both years and the lowest being in I₄ (3809 and 4300 kg/ha in I and II year respectively).

Among seed hardening treatments, S3 (seed treatment with chatmatkar 125 ppm + foliar spray of KCl 0.5%) has recorded higher grain yields of 4766 kg/ha and 5325 kg/ha in I and II year respectively. This was followed by foliar spray of KCl 0.5% (S4) and these two treatments are significantly superior to others. The increased grain yield in these treatments were due to significant influence on growth characters and yield attributes. These findings are in line with earlier reports of Singh and Chatterjee (1980), and Narayanasamy (1991).

The interactions between irrigation scheduling and seed hardening in rice did not show marked influence.

Water consumption and water use efficiency

The total water use (water requirement) was higher with irrigation scheduling at weekly intervals (II) with 1185 and 1167 mm in I and II year respectively followed by weekly irrigations upto 60 DAE (I₃) (Table 3). Though the water requirement was lower in fortnightly irrigation both upto 45 and 60 DAE (I₂ and I₄) the grain yields were reduced in these treatments to the extent of 16.36 and 18.85 per cent over II in I year and 15.20 and 17.65 per cent in II year in I₂ and I₄ treatments respectively.

The water use efficiency was higher with irrigation at weekly intervals upto 60 DAE (I₃) i.e., 4.23 and 4.73 kg/ha mm⁻¹ in I and II year respectively followed by weekly irrigations upto 45 DAE (II) (3.94 and 4.47 kg/ha mm⁻¹ in I and II year respectively). Fortnightly irrigations both upto 45 and 60 DAE registered lower water use efficiency.

Thus, for semi dry rice, irrigations at weekly intervals upto 45 or 60 DAE was found to be high yielding over fortnightly irrigations. As fortnightly irrigations lead to moisture stress for prolonged period, the growth of rice at early vegetative phase was very much affected. This stress period due to weekly irrigations could be mitigated by seed hardening with chatmatkar 125 ppm and foliar spray of KCl 0.5%.

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