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Time of Start of Irrigation and Weed Management Practices on Performance of Dry Seeded Irrigated (Semi Dry) Rice

G. Sreenivas*, D. Raji Reddy and P. Leela Rani

Department of Agronomy, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad

*Corresponding author: gsreenivas2002@gmai.com

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Abstract

Experiments was conducted at College farm, College of Agriculture, Rajendranagar, Hyderabad to find out ideal time of irrigation and best weed management practice under dry seeded irrigated condition. Experiment was laid out with three irrigation schedules (starting of irrigation from 45, 60 and 75 DAE) as main plots and five weed management treatments (pre-emergence application of butachlor @ 1 kg ha-1 fb 2, 4-D Na salt @ 1 kg ha-1 at 30 DAE, pre-em application of pretilachlor @ 0.75 kg ha-1 fb 2, 4-D Na salt @ 1 kg ha-1 at 30 DAE, interculture at 20 DAE fb HW at 40 DAE, interculture at 20 DAE fb HW at 40 and 60 DAE and unweeded check) as sub plots in split plot design replicated thrice.Scheduling of irrigation from 45 DAE resulted in significantly higher grain yield than irrigation started from 60 DAE which inturn resulted in significantly higher yield than that of irrigation scheduled from 75 DAE. The total water input (effective rainfall + irrigation) was higher in irrigation scheduled from 45 DAE, while the water productivity was higher in irrigation scheduled from 60 DAE. Higher B:C ratio was obtained with irrigation scheduled from 45 DAE than that of irrigation started from 60 and 75 DAE. Among the weed management treatments, interculture at 20 DAE fb HW at 40 and 60 DAE recorded significantly lower weed DMP, higher WCE, number of panicles and grain yield than that of pre-em application of pretilachlor @ 0.75 kg ha-1 fb 2, 4-D Na salt @ 1 kg ha-1. Number of panicles and yield were comparable with pre-em application of pretilachlor @ 0.75 kg ha-1 fb 2, 4-D Na salt @ 1 kg ha-1 and butachlor @ 1 kg ha-1 fb 2, 4-D Na salt @ 1 kg ha-1 at 30 DAE. Higher water productivity and B:C ratio were obtained with interculture at 20 DAE fb HW at 40 and 60 DAE.

Key words: Dry seeded irrigated rice, Weed drymatter, WCE, Effective rainfall, Grain yield and Water productivity

Introduction

Rice, in India, is cultivated under varied ecosystems - rainfed upland and low land and irrigated. The rainfed lowland and upland rice is usually direct seeded into dry soil. On the other hand, the irrigated rice is established either by transplanting or direct seeding under puddled condition or dry seeding. Irrigated rice requires about 3,000 – 5,000 L of water to produce 1 kg of grain (IRRI, 2001). Because of this high water requirement, the increasing water shortage threatens the sustainability of the irrigated rice system (Tuong and Bouman, 2002). Considering the future population growth, competition from non-agricultural uses of water and increasing demand for agricultural products, available water needs to be used efficiently. To reduce the share of water in rice cultivation, it is imperative to develop new way of growing rice that uses less water, while maintaining high yields. Dry seeded irrigated (Semi-dry) rice culture is a system associated with upland condition in the early and low land situation at later stages of crop growth. The semi-dry rice is characterized by sowing of dry seed with the help of monsoon rains and subsequently converting it into wet condition by using tank, canal or ground water. Dry seeded rice offers scope to advance crop establishment and to increase the effective use of early season rainfall (Tuong, 1999). The time of starting of conversion of dry rice to wet land or irrigated dry rice plays major role in obtaining higher yields. It has been reported that similar yields as that of transplanted rice can be obtained by scheduling irrigation as that of irrigated dry crop. Further, irrigation of semi-dry rice with 5 cm at weekly intervals upto 45-60 DAE significantly improved the yield over that at fortnightly irrigations (Thyagarajan and Selvaraju, 2001). These results indicated that there is greater scope for scheduling the irrigation water for rice crop production. Further, providing need-based irrigation by taking rainfall into consideration, considerable quantity of water can be saved. Hence, an experiment with scheduling of irrigation was carried. In dry seeded rice ecosystems, weeds and rice emerge simultaneously, and weeds compete with rice plant for light, nutrients and moisture resulting in reduction of grain yield upto 80 per cent (Sinha Babu *et al.,* 1992). Manual weeding of dry seeded rice fields is labour oriented and expensive. The traditional hand weeding practice needs to be substituted by herbicides to control weeds timely and economically. There is a need to develop integrated weed management for effective weed control in irrigated dry seeded rice. Keeping in view the investigation was carried out with aim to identify optimum time for starting of irrigation and weed management practices for higher grain yield of rice under dry seeded irrigated conditions

Material and Methods

The investigation was carried out during *kharif*, 2003 at College farm, College of Agriculture, Rajendranagar, Hyderabad situated at an altitude of 542.6 m above mean sea level on 17°19' N latitude and 78°23' E longitude. The mean weekly maximum temperature during cropping period ranged from 27.5 to 35.2°C. The weekly mean minimum temperature varied between 9.5 to 24.0°C. The mean relative humidity fluctuated between 26.3 to 93.9 per cent.Rainfall of 810.2 mm was received in 45 rainy days. The weekly mean bright sunshine hours per day varied from 2.0 to 9.3 hours and mean evaporation ranged from 2.2 to 8.4 mm day^{-1}during crop growing season.

The experiment was conducted in sandy clay loam soil having pH 7.7with available nitrogen 279.5 kg ha^{-1}, phosphorous 10.9 kg ha^{-1} and available potassium of 128.95 kg ha^{-1}. three times of start of irrigation *viz.,* 45 DAE, 60 DAE and 75 DAE in main plots and five weed management treatments *viz.,* pre-em application of butachlor @ 1 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE, pre-em application of pretilachlor @ 0.75 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE, IC at 20 DAE fb HW at 40 DAE, IC at 20 DAE fb HW at 40 and 60 DAE and unweeded check in sub plots in a split-plot design. The treatments were replicated thrice in both the experiments. The experiment was sown on 16 July, 2003 using medium duration cultivar Polasa Prabha (JGL 384) and harvested on 30 November 2003. Sowing was done with dry seed in solid rows at 20 cm spacing between two rows. A seed rate of 400 seeds m^{-2} was used. A uniform level of 140 kg ha^{-1} N as urea, 60 kg ha^{-1} P_2O_5 as single super phosphate, 40 kg ha^{-1} K_2O as muriate of potash was applied to all the treatments. The entire P_2O_5, K_2O and $ZnSO_4$ @ 50 kg ha^{-1} were applied at sowing . The nitrogen was applied in three splits -1/3 each at sowing, active tillering and panicle initiation stages. Irrigation was applied as per the treatments with a depth of irrigation was 5 cm. An area of one m^2 was earmarked in each net plot randomly for recording the observations on weed density. Weeds were removed from 0.25 m^2 area using the quadrat from outside the net plot at 30, 60, 90 DAE and harvest. The samples were shade dried and then oven dried at 75°C to a constant weight.

Results and Discussion

During crop growth period, ten weed species comprising five monocots *viz.Echinochloa colona* L, *Dinebra retroflexa* L, *Cynodon dactylon* pers., *Dactyloctenium aegyptium* Beauv *and Cyperus rotundus* L. and five dicots were *Eclipta alba* Hassk, *Caesulia axillaris* Rozb, *Parthenium hysterophorus* L, *Trianthema portulacastrum* L and *Amaranthus viridis* L were observed.

Time of starting of irrigation

Time of start of irrigation did not affect the weed density, weed dry matter and weed control efficiency at any stage of the crop growth (Table 1). Significantly higher grain yield was obtained with irrigation started from 45 DAE than that from 60 and 75 DAE and it was 8.98 and 38.8 per cent higher in the former irrigation treatment than that of latter treatments (Table 2). Irrigation given from 60 DAE recorded 27.4 per cent higher grain yield than that of irrigation from 75 DAE. Irrigation started from 75 DAE recorded significantly lower grain yield.

The higher grain yield with irrigation scheduled from 45 DAE was mainly due to higher amount of total water input (effective rainfall + irrigation) during crop growth period than with irrigation scheduled from 60 DAE (Table 4). The water deficit through effective rainfall before start of irrigation was 23 per cent in the irrigation scheduled from 45 DAE. Further with delay in schedule of irrigation 60 and 75 DAE, there was 40.2 and 37.2 per cent deficit water (effective rainfall) respectively than that of water requirement in respective irrigation treatments (Table 3).

Greater quantity of required water could be met through the rainfall before start of irrigation in irrigation scheduled from 45 DAE (77%) than that of irrigation scheduled from 60 DAE (60%) and 75 DAE (63%), which might have resulted in higher grain yield in the former treatment than that of the latter irrigation treatments.

Greater amount of water was received during its growth period in the irrigation treatment at 45 DAE that might have resulted in higher number of panicles and less spikelet sterility (Table 2) as compared to irrigation scheduled 60 and 75 DAE. This might be due to higher water input in irrigation scheduled from 45 DAE might have resulted in higher grain yield than that of irrigation scheduled from 60 DAE. There are reports that in dry seeded rice, submergence at 30 or 45 DAE recorded higher grain yield and further delay in irrigation reduced grain yield (Govindasamy *et al.,* 1992). The results obtained in the present study corroborate this.

Higher gross and net income and B:C ratio was obtained with irrigation scheduled from 45 DAE than that of 60 and 75 DAE (Table 5). Higher initial growth due to lower deficit (23%) rainfall helped in increased grain yield in irrigation scheduled from 45 DAE as compared to irrigation scheduled from 60 and 75 DAE.

Weed Management

There was lower weed density and DMP, and higher WCE at 90 DAE in the crop with interculture at 20 DAE fb HW at 40 and 60 DAE than that of interculture at 20 DAE fb HW at 40 DAE (Table 1). At 30 and 60 DAE, weed dry weight was comparable between intercultureat 20 DAE fb HW at 40 and 60 DAE and interculture at 20 DAE fb HW at 40 DAE. The total removal of weeds at 60 DAE in interculture at 20 DAE fb HW at 40 and 60 DAE caused lower crop-weed competition, thereby lower weed dry weight at 90 DAE and harvest than interculture at 20 DAE fb HW at 40 DAE. The critical period of weed competition for upland rice was upto 60 DAS (Ali and Sankaran, 1984). The variation of critical period of weed competition was due to variation in crop growth rate during 60-90 days (Bhargavi and Reddy, 1990).

An increase in panicle number might be contributed to higher grain yield in interculture at 20 DAE fb HW at 40 and 60 DAE (Table 2). On the other hand, interculture at 20 DAE fb HW 40 DAE recorded 52.4 and 32.0 per cent higher weed dry matter at 90 DAE and harvest, respectively than interculture at 20 DAE fb HW at 40 and 60 DAE thereby lower grain yield in former treatment.

Significantly higher grain yield and water productivity was obtained with interculture at 20 DAE fb HW at 40 and 60 DAE than that at 20 DAE fb HW at 40 DAE, which in turn recorded significantly higher grain yield over pre-em application of pretilachlor @ 0.75 kg ha^{-1} fb 2,4-D Na salt @ 1 kg ha^{-1} at 30 DAE and butachlor @ 1 kg ha^{-1} fb 2,4-D Na salt @ 1 kg ha^{-1} at 30 DAE. The grain yield in the latter two treatments was comparable and significantly higher than that of unweeded check (Table 2).

Interculture at 20 DAE fb HW at 40 DAE recorded 19.7 per cent higher grain yield than pre-em application of pretilachlor @ 0.7 kg ha^{-1} fb 2,4-D Na Salt @ 1 kg ha^{-1} at 30 DAE. The former treatment recorded 28.9, 18.3 and 16.7 per cent higher crop dry matter accumulation at PI, heading and harvest, respectively than the latter treatment. In interculture at 20 DAE fb HW at 40 DAE, the total removal of weeds due to HW at 40 DAE resulted in lower weed dry weight and higher WCE at 60 and 90 DAE, resulting in the higher panicle number per unit area thereby increased grain yield. It has been reported that in drilled rice, mechanical weeding at 35 DAE fb HW at 40 DAE resulted in higher Weed Control Efficiency (Prusty*et al.,* 1990). At 30 DAE, pre-em application of pretilachlor @ 0.75 kg ha^{-1} fb 2,4-D Na salt @ 1 kg ha^{-1} at 30 DAE resulted in lower weed density, weed weight and WCE than interculture at 20 DAE fb HW at 40 DAE. Though pre-em application of pretilachlor @ 0.75 kg ha^{-1} effectively reduced the weed dry weight at 30 DAE, it could not give higher grain yield due to severe crop weed competition in later crop growth stages. Pre-em application of pretilachlor @ 0.75 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1}at 30 DAE resulted in reduced density of broad leaved weeds, resulting in dominance of monocots, which led to higher weed dry weight at 60 DAE. On the other hand, the weeds were effectively removed at 40 DAE by HW in the treatment IC at 20 DAE fb HW at 40 DAE, which resulted in lower crop weed competition thereby improved grain yield.

Pre-em application of pretilachlor @ 0.75 kg ha^{-1} fb 2,4-D Na salt @ 1 kg ha^{-1} at 30 DAE and butachlor @ 1 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE recorded comparable grain yield and significantly higher than that of unweeded check. Pre-em application of butachlor @ 1 kg ha^{-1} fb 2,4-D Na salt @1 kg ha^{-1} at 30 DAE effectively reduced the weed dry weight, which resulted in higher WCE due to low crop weed competition throughout the crop growth period. Better control of weeds with application of butachlor in semi-dry rice led to higher panicles, yield attributes and grain yield than that of unweeded check (Nair *et al.,* 1979). The severe crop weed competition throughout the crop growth period reduced panicles and grain yield of rice.

Higher gross and net income and B:C ratio were obtained with IC at 20 DAE fb HW at 40 and 60 DAE followed by IC at 20 DAE fb HW at 40 DAE because of increased yield, reduced weed dry weight at 60 and 90 DAE and harvest. Lower B:C ratio was recorded in pre-em application of butachlor @ 1 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE and pretilachlor @ 0.75 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE as a result of low yield as compared to IC at 20 DAE and HW at 40 and 60 DAE because of the weed control was less effective in this treatment.

From these results, it can be concluded that, scheduling irrigation from 45 DAE with adoption of IC at 20 DAE fb HW at 40 and 60 DAE will improve the yield and net returns of dry seeded irrigated rice in south Telangana agro climatic zone of Telangana.

References

Ali, A.M. and Sankaran, S. 1984. Crop-weed competition in direct seeded lowland and upland rice. *Indian Journal of Weed Science* 16 : 90-96.

Bhargavi, K. and Reddy, Y.T. 1990 Effect of time and method of application of herbicides on weed control in semi-dry rice (*Oryza sativa* L.). *Indian Journal of Agricultural Sciences* 60(2): 147-150.

Govindasamy, K.N., Lakshminarayana, T. and Subramanian, S. 1992. Effect of submergence timing and application of *Azospirillum* and K on direct seeded rice. *International Rice Research Newsletter* 17 (4): 18.

IRRI 2001 Annual report 2000-2001 : Rice research : the way forward : Los Banos ,Philippines. International Rice Research Institute. pp.71.

Sinha Babu, D.P., Moorthy, B.T.S., Rajamani, S. and Manna, G.B. Integrated weed management benefits direct seeded upland rice. *Indian Farming* 42:7-8.

Thyagarajan, T.M. and Selvaraju, R. 2001. Water-saving rice cultivation in India. In: Proceedings of International workshop, Water-saving rice production systems, Nanjing University, China, April 2-4, 2001. Plant Research International, Wageningen, report 33, pp 15-45.

Tuong, T.P. 1999. Productive water use in rice production: Opportunities and limitations. *Journal of Crop Production* 2: 241-264.

Tuong, T.P. and Bouman, B.A.M. 2002. Rice production in water scarce environments. To be published in proceedings of the water productivity workshop, 12-14 Nov.2001, International Water Management Institute, Sri Lanka.

Table 1. Weed density, weed dry matter and weed control efficiency as affected by time of start of irrigation and weed management practices in dry seeded irrigated rice

Treatment	Weed density (number m^{-2})				Weed dry matter (g m^{-2})				Weed control efficiency (%)			
	30 DAE	60 DAE	90 DAE	Harvest	30DAE	60DAE	90DAE	Harvest	30DAE	60DAE	90DAE	Harvest
Time of irrigation (I)												
45 DAE	10.21 (106)	9.74 (100.8)	8.19 (71)	6.59 (50)	39.5	77.4	92.6	67.5	42.6	58.4	65.2	69.8
60 DAE	9.95 (102)	9.13 (89)	8.14 (71)	6.81 (52)	34.6	68.6	97.7	73.1	56.5	63.4	65	71
75 DAE	10.09 (103)	9.18 (90)	7.89 (67)	6.55 (50)	42.1	70.2	105.9	83.5	55.5	63.9	64.5	73
SEm±	0.28	0.35	0.25	0.15	3.6	2.4	4.5	4.4	-	-	-	-
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	-	-	-	-
Weed management (W)												
W_1	8.71 (76)	9.32 (87)	8.24 (68)	6.10 (37)	16.9	82.4	103.7	68.4	72.9	44.5	49.6	60.4
W_2	8.38 (71)	9.14 (84)	8.03 (65)	6.01 (36)	15.1	82	102	62.1	74.6	44.7	50	63.6
W_3	10.67 (114)	7.45 (56)	6.78 (47)	5.29 (28)	49	32.6	55.1	40	31.7	78.5	72.9	76.7
W_4	10.39 (109)	7.19 (52)	5.39 (29)	4.37 (19)	49.7	30.2	26.2	27.2	27	79.9	87.1	84.4
W_5	12.12 (148)	13.66 (187)	11.92 (142)	11.48 (132)	62.9	133.4	206.8	175.8	0	0	0	0
SEm±	0.36	0.29	0.34	0.29	3.8	4.6	5.4	6.1	-	-	-	-
CD (P=0.05)	1.05	0.86	0.99	0.85	11.1	13.5	15.8	17.8	-	-	-	-
Interaction (IxW)												
SEm±	0.62	0.51	0.59	0.5	6.6	8	9.4	10.5	-	-	-	-
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	-	-	-	-

W_1 - Pre-em butachlor @ 1 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE.

W_2 - Pre-em pretilachlor @ 0.75 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE.

W_3 - IC at 20 DAE fb HW at 40 DAE

W_4 - IC at 20 DAE fb HW at 40 and 60 DAE

W_5 - Unweeded check

Table 2. Yield attributes and grain yield of rice as affected by time of start of irrigation and weed management practices in dry seed irrigated rice

Treatment	Panicles m^{-2}	Spikelets $Panicle^{-1}$	Filled spikelets $panicle^{-1}$	Spikelet sterility (%)	Test weight (g)	Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Harvest index (%)
Time of irrigation (I)								
45 DAE	230	104	80.4	24.4	13.7	2.79	5.06	35
60 DAE	217	105.3	78	28	13.6	2.56	4.84	34.2
75 DAE	193	102.5	74.2	29.6	13.5	2.01	4.05	31.7
SEm±	4	2	1.5	0.4	0.1	0.06	0.05	-
CD (P=0.05)	16	NS	NS	1.4	NS	0.23	0.21	-
Weed management (W)								
W_1	216	110	84.7	23	13.7	2.21	4.48	32.8
W_2	221	111.6	85.3	23.5	13.7	2.32	4.67	33.2
W_3	247	116	89.7	22.6	13.8	2.89	5.58	34
W_4	276	120.8	94	22.1	13.9	3.66	6.04	37.6
W_5	105	61.2	34	44.4	13	1.19	2.47	30.8
SEm±	8	2.1	1.7	0.6	0.1	0.12	0.1	-
CD (P=0.05)	23	6.1	5.1	1.5	0.2	0.35	0.29	-
Interaction (IxW)								
SEm±	14	3.6	3	1	0.1	0.21	0.17	-
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.6	-

W_1 - Pre-em butachlor @ 1 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE.

W_2 - Pre-em pretilachlor @ 0.75 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE.

W_3 - IC at 20 DAE fb HW at 40 DAE

W_4 - IC at 20 DAE fb HW at 40 and 60 DAE

W_5 - Unweeded check

Table 3. Effective rainfall and water requirement in different irrigation treatments before start of irrigation of dry seeded irrigated rice

Time of irrigation	Effective rainfall(mm)	Water requirement (mm)	Deficit (%)
45 DAE	160.0	207.7	23.0
60 DAE	163.2	272.9	40.2
75 DAE	210.8	335.4	37.2

Table 4. Effective rainfall, irrigation water, total water and water productivity as influenced by time of start of irrigation and weed management treatments in dry seeded irrigated rice

Treatment	Effective rainfall(mm)	Irrigation water (mm)	Total water (mm)	Water productivity ($kg\ m^{-3}$)
Starting of irrigation at 45 DAE	226.5	730.0	956.5	0.29
Starting of irrigation at 60 DAE	244.3	580.0	824.3	0.31
Starting of irrigation at 75 DAE	248.3	440.0	688.3	0.29

Table 5. Gross income, cost of cultivation, net income and B:C ratio as influenced by time of irrigation and weed management practices in dry seeded irrigated rice

Treatment	Gross income (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net income (Rs ha^{-1})	B:C
Time of irrigation (I)				
45DAE	17700	12425	5275	1.42
60DAE	16300	12316	3984	1.32
75DAE	12873	12196	677	1.06
Weed management (W)				
W_1	14162	12278	1884	1.15
W_2	14860	12491	2369	1.19
W_3	18436	12392	6044	1.49
W_4	23040	12842	10198	1.79
W_5	7643	11642	-3999	0.66

W_1 - Pre-em butachlor @ 1 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE.

W_2 - Pre-em pretilachlor @ 0.75 kg ha^{-1} fb 2, 4-D Na salt @ 1 kg ha^{-1} at 30 DAE.

W_3 - IC at 20 DAE fb HW at 40 DAE

W_4 - IC at 20 DAE fb HW at 40 and 60 DA+E

W_5 - Unweeded check