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Weed population and biomass in direct-seeded rice (*Oryza sativa*) as influenced by irrigation

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ABSTRACT

The response of lowland weeds and rice (*Oryza sativa* L.) to various water-management practices was determined at the wetland farms of Coimbatore, during the rainy and winter seasons (1997–98 and 1998–99). Weed population and growth were generally higher during the rainy season than winter season. Variation in irrigation regimes brought about distinct changes in weed growth and establishment in rice fields. Irrigating 5 cm depth 1 day after disappearance of ponded water in transplanted rice recorded the lowest number of weeds, viz. grasses, sedges and broad-leaved weeds and the lowest dry weight of weeds. However, irrigating 5 cm depth 1 day after disappearance of ponded water in direct-seeded rice and continuous submergence of 2.5 cm depth were at par with transplanted rice. Lower water regimes recorded the maximum weed population and biomass due to lack of flooding.

Transplanted rice recorded more water use than the direct-seeded rice. The highest grain yield was recorded with direct-seeded rice during the rainy and by transplanted rice during winter season. Benefit : cost ratio was more for the higher water regimes of direct-seeded rice than transplanted rice as transplanted rice required more labour for raining nursery and for transplanting.

Key words : Direct-seeded rice, Weed, Biomass, Irrigation

In rice, establishment methods and irrigation methods are location specific and so it is very difficult to evolve a common management technique. Scarcity of water for irrigation and increasing cost of transplanting encouraged many farmers to switch over from transplanting to direct-seeding. Under conditions of paucity of water, judicious water management is essential in utilizing the water more economically. In wet seeded rice, weed management is one of the most critical factors because the soil conditions are favourable for simultaneous germination of weed seeds along with rice seeds (James Martin, 1995).

Water serves as an effective means of weed control as many weeds cannot germinate under flooded conditions (Bhagat *et al.*, 1996). Too low or too high soil water content prevents the growth and development of lowland rice weeds. As such studies as influenced by various water-management practices are meagre, the present investigation was carried out under puddled, lowland conditions.

MATERIALS AND METHODS

The field experiment was conducted in the wetland farms of Tamil Nadu Agricultural University, Coimbatore, during rainy season (June 1997–October 1997) and winter (September 1997–January 1998) season. The soil of the experimental field was clay loam with pH 7.6, EC 0.5 dS/m and field capacity 30%. The bulk density was 1.33 g/cc with 1.5 cm/day as infiltration rate. The amount of rainfall received during the rainy and winter seasons was 49.4 and 514.5 mm respectively. The available status of N, P_2O_5 and K_2O was 248, 15 and 550 kg/ha respectively. 'ASD 18' and 'IR 20' rice varieties were used.

The experiment was laid out in randomized block design with 9 irrigation regimes. All the treatments were replicated 3 times. The irrigation regimes included 8 irrigation regimes in direct-seeded, puddled rice and 1 irrigation regime in transplanted rice as : I_1, irrigation to 5 cm depth 1 day after disappearance of ponded water; I_2, irrigation to 5 cm depth 3 days after disappearance of ponded water; I_3, continuous submergence of 2.5 cm depth throughout the crop period; I_4, irrigation to 2.5 cm depth 1 day after disappearance of ponded water; I_5, irrigation to 2.5 cm depth 3 days after disappearance of ponded water; I_6, saturation throughout the crop period; I_7, maintaining 5 cm depth of water during critical stages and maintaining saturation during other stage; I_8, maintaining 2.5 cm depth of water during critical stages and maintaining saturation during other stages; and I_9, transplanted rice : irrigation to 5 cm depth 1 day after disappearance of ponded water.

Here the critical stages include active tillering, panicle initiation and flowering. Direct-sowing was carried out by drum seeder developed by the Tamil Nadu Agricultural University, Coimbatore, using pre-germinated seeds. Agronomic practices were followed as per recommendations. Irrigation requirement was measured by means of 'V' notch. No specific weed-management practice was followed. The observations on weed population as influenced by irrigation regimes were made at 60 days after transplanting or sowing (DAS) and on weed dry weight at 30, 45 and 60 days.

The major weeds observed in the experimental site were *Echinochloa colona, Echinochloa crus-galli* and *Paspalum distichum* among grasses; *Cyperus iria* (sedge); and *Eclipta alba, Marselia quadrifolia, Ludwijia parviflora* and *Monochoria vaginalis* among broad-leaved weeds.

RESULTS AND DISCUSSION

Weed population

Irrigation levels significantly influenced the population of grasses, sedges and broad-leaved weeds in both the seasons (Table 1). The lowest population of weeds was recorded with irrigation 5 cm depth 1 day after disappearance of ponded water in transplanted rice (I_9). However, irrigating 5 cm depth 1 day after disappearance of ponded water in direct-seeded rice (I_1) and continuous submergence of 2.5 cm depth throughout the crop period (I_3) were at par with the irrigation regime I_9. The highest population of weeds was recorded with irrigating 2.5 cm depth 3 days after disappearance of ponded water (I_5) and saturation throughout the crop period (I_6).

Continuous shallow submergence reduced the weed population considerably due to possible inhibition of germination of weed seeds under anaerobic condition (Table 1). This would also explain the greater weed growth under irrigation given 3 days after disappearance of ponded water and maintaining saturation throughout the crop period provided better aeration and exposure of soil surface favourable for weed germination (Misra *et al.*, 1981; Bhagat *et al.*, 1996). Similar observations on weed growth being modified by irrigation regimes in rice were made by Raju and Reddy (1987) and Nartsomboon and Moody (1988). Control of weeds due to

Table 1. Influence of water regimes on weed population in direct-seeded rice

Treatment	Weed population/m²					
	Grasses		Sedges		Broad-leaved weeds	
	Rainy season	Winter season	Rainy season	Winter season	Rainy season	Winter season
I_1	1.54 (33.33)	1.46 (26.67)	1.61 (38.66)	1.38 (22.00)	1.77 (56.67)	1.43 (24.67)
I_2	1.63 (40.67)	1.48 (28.67)	1.63 (40.66)	1.46 (26.67)	1.79 (59.33)	1.53 (31.33)
I_3	1.55 (34.00)	1.47 (27.33)	1.62 (40.00)	1.34 (20.00)	1.77 (57.33)	1.45 (26.00)
I_4	1.59 (37.33)	1.53 (32.00)	1.69 (46.66)	1.36 (20.67)	1.78 (58.66)	1.55 (33.33)
I_5	1.64 (42.66)	1.57 (35.33)	1.69 (47.33)	1.45 (26.00)	1.82 (63.33)	1.53 (32.00)
I_6	1.62 (39.33)	1.58 (36.00)	1.70 (48.00)	1.47 (27.33)	1.83 (66.00)	1.54 (32.00)
I_7	1.64 (42.00)	1.56 (34.00)	1.66 (44.00)	1.50 (29.33)	1.83 (65.33)	1.56 (34.66)
I_8	1.64 (41.33)	1.56 (34.66)	1.68 (46.00)	1.48 (28.00)	1.82 (64.00)	1.47 (27.33)
I_9	1.53 (32.00)	1.45 (26.00)	1.60 (38.00)	1.32 (18.67)	1.76 (55.33)	1.41 (24.00)
CD (P = 0.05)	0.08	0.10	0.07	0.11	0.05	0.09

Figures in parentheses indicate original values
For treatment details, refer text

Table 2. Influence of water regimes on weed dry weight in direct-seeded rice (g/m²)

Treatment	Rainy season			Winter season		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
I_1	16.39	28.25	40.16	32.38	21.53	35.93
I_2	17.33	28.83	42.51	33.32	22.89	36.67
I_3	15.63	27.71	38.63	31.15	21.12	35.59
I_4	17.74	30.05	41.62	34.00	21.97	37.42
I_5	16.99	31.34	45.77	37.19	24.83	41.38
I_6	18.76	32.62	46.71	36.44	24.35	39.75
I_7	18.39	30.76	44.89	35.74	23.46	40.54
I_8	18.06	31.95	44.06	35.09	23.89	39.02
I_9	15.92	27.21	39.37	31.73	20.73	35.23
CD (P=0.05)	NS	3.49	3.03	NS	2.66	4.42

For treatments details, refer text

flooding was accomplished by an interaction of the changes in the physical, chemical and biological properties of the soil.

Weed dry-matter

The weed biomass was significantly influenced by the irrigation levels in variably in all the stages except 30 DAS and in both the seasons. The lowest dry weight of weeds was recorded under treatment I_9. However, irrigating 5 cm depth 1 day after disappearance of ponded water in transplanted rice (I_1) and continuous submergence of 2.5 cm depth throughout the crop period (I_3) did not significantly differ with the above irrigation regime I_9. Lesser weed population as under irrigation regimes I_9 and I_3 could be attributed as reason for lesser weed biomass (Table 2). Raju *et al.* (1995) observed the minimum weed biomass under high pond water potential than under alternate wet-dry system.

Yield, water use and economics

Irrigation to 5 cm depth/day after disappearance of ponded water in direct-seeded rice (I_1) recorded the highest grain yield in the rainy season 1997. The same irrigation regime with transplanted rice (I_9) recorded the highest grain yield in winter 1997. However, continuous submergence of 2.5 cm depth throughout the crop period was not significantly different from the above-irrigation regimes. In both the seasons, irrigating 2.5 cm depth 3 days after disappearance of ponded water (I_5) recorded the lowest grain yield because rice plants experienced moisture stress in this irrigation regime. The results are in line with the findings of Packiaraj and Venkatraman (1991).

The maximum water use was recorded with transplanted rice–irrigating 5 cm depth 1 day after disappearance of ponded water (I_9), as more water was required for raising nursery and for extended land preparation.

Table 3. Grain yield and water-use efficiency of direct-seeded rice as influenced by irrigation regimes

Treatment	Grain yield (kg/ha)		Total water applied (cm)		Water-use efficiency (kg/ha-cm)		Net returns (Rs/ha)		Benefit : cost ratio	
	Rainy season	Winter season	Rainy season	Winter season	Rainy season	Winter season	Rainy season	Winter season	Rainy season	Winter season
I_1	5,505	5,107	110	104	49.7	48.9	17,704	20,237	2.58	2.67
I_2	4,952	4,751	99	97	49.6	48.9	15,117	18,146	2.36	2.51
I_3	5,283	5,053	104	99	50.6	51.4	16,658	19,896	2.49	2.63
I_4	5,060	4,837	101	97	50.0	50.1	15,589	18,549	2.39	2.54
I_5	4,342	4,158	95	94	45.6	44.4	12,136	14,485	2.09	2.20
I_6	4,471	4,228	95	93	46.8	45.4	12,723	14,908	2.14	2.23
I_7	4,756	4,528	97	96	48.9	47.5	14,406	16,661	2.29	2.38
I_8	4,655	4,432	96	95	48.3	46.9	13,615	16,051	2.22	2.33
I_9	5,428	5,288	138	125	39.2	40.9	16,445	20,479	2.36	2.58
CD (P=0.05)	232	249								

For treatment details, refer text

Bhuiyan *et al.* (1995) also reported more water requirement for transplanted rice compared with direct-seeded rice. This ultimately reduced the water-use efficiency of transplanted rice. The highest water-use efficiency was recorded with continuous submergence of 2.5 cm depth throughout the crop period (I_3) in both the seasons, as it gave more grain yield with minimum quantity of water compared with I_1 and I_2 treatments.

The highest net returns was recorded with irrigating 5 cm depth 1 day after disappearance of ponded water in direct seeded rice (I_1) and transplanted rice (I_9) respectively during the rainy and winter seasons 1997. Though transplanted rice produced maximum net returns during the winter 1997, the benefit : cost ratio was less than I_1 and I_3 treatments due to the fact that transplanted rice required more labour for transplanting and more water than direct-seeded rice (Table 3).

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