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Integrated weed management practices for rice under aerobic culture

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ABSTRACT

A field experiment was conducted to study the effect of irrigation and weed management practices of rice under aerobic culture, laid in split plot design. Among the irrigation schedules, IW/CPE ratio of 1.2 produced significantly higher stature of yield attributes, *viz.*, total number of panicles/m^2, total number of grains/panicle and number of filled grains/panicle and grain and straw yield were distinctly superior to other two irrigation schedules. At all the stages, with exception at 20 DAS, the lowest of density of weeds and their corresponding dry weight was recorded with hand weeding at 20 and 40 DAS, which were comparable with oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS for density of grasses, triasulfuron 0.006 kg/ha supplemented with HW at 40 DAS for density of broad leaved weeds and bensulfuron methyl 0.06 kg/ha supplemented with HW at 40 DAS for density of sedges. The highest density of these entire weed categories was recorded with unweeded check. The study revealed that rice can be successfully grown under aerobic culture in north coastal zone of Andhra Pradesh, with pre-emergence application of oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS for higher productivity.

Key words: Aerobic rice, Bensulfuron-methyl, Chemical control, IW/CPE, Oxadiargyl

To fulfill the increased rice demand with shrinking resources, it will be necessary to increase yield in a unit area with less water. Water is a looming crisis due to competition among agricultural, industrial, environmental and domestic users. The new concept of aerobic rice entails the use of nutrient-responsive cultivars that are adapted to aerobic culture aiming at yields of 70-80% of high input flooded rice. The target environments are irrigated lowlands, where water is insufficient to keep lowland (rainfed or irrigated) paddy fields flooded and favorable uplands with access to supplementary irrigation. The successful transition from traditional lowland cultivation to aerobic rice production should be invariably under conditions of effective water management, to keep the soil ''wet'' but not flooded or saturated. In practice, irrigation has to be applied to bring the soil water content up to field capacity once a lower threshold has been reached and hence for aerobic rice, the optimum threshold for re-irrigation still needs to be determined.

Weeds are the greatest threat under upland or aerobic rice systems, resulting in yield losses between 30 and 98% (Oerke and Dehne 2004). Successful aerobic rice culture will largely depend on effective weed control. The use of herbicides causes environmental pollution and induces the proliferation of resistant weed biotypes. These risks and the costs of labour for weeding prompt research on environment friendly, low volume and labour efficient methods of weed control for aerobic rice. North Coastal region of Andhra Pradesh is having substantial area under rainfed/semi-dry rice and has a vast scope of growing rice under aerobic conditions. In this backdrop, the present study was undertaken with the objectives to determine the best irrigation water management practice and to find out the effective weed management practice for aerobic rice for maximum performance of aerobic rice.

MATERIALS AND METHODS

An experiment for water and weed management practices in aerobic rice was carried out during *Kharif* 2007 and 2008 at upland block of college farm, Agricultural College, Naira campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh, situated at 18.24^0 N latitude, 83.84^o E longitude and at an altitude of 27 m above mean sea level in the North coastal zone of Andhra Pradesh. Weather parameters *viz*., temperature, RH, bright sunshine hours and evaporation varied negligibly between *Kharif*, 2007 and 2008. The weather parameters, during both years of study did not deviate much from the normal values of the location and were favorable for the optimal performance of the crop. During the crop period during *Kharif* 2007, a total amount of 488.5 mm rainfall was received in 28 rainy days as against the decennial average of 595 mm received in 32 rainy days for the corresponding period and during *Kharif* 2008, a total amount of 444.5 mm rain-

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fall was received in 28 rainy days as against the decennial average of 592 mm received in 32 rainy days for the corresponding period.

The experiment was laid out in split-plot design and replicated thrice. The treatments consisted of three irrigation schedules (M_1- IW/CPE ratio of 0.8, M_2- IW/CPE ratio of 1.0 and M_3- IW/CPE ratio of 1.2) and five weed management practices (S_1- unweeded check, S_2- hand weeding (HW) twice at 20 and 40 DAS, S_3- pre-emergence application of oxadiargyl 0.07 kg/ha + hand weeding at 40 DAS, S_4- pre-emergence application of bensulfuron-methyl 0.06 kg/ha + hand weeding at 40 DAS and S_5- pre-emergence application of triasulfuron 0.006 kg/ha + hand weeding at 40 DAS as sub-plots. A fertilizer dose of 120-60-50 kg N, P_2O_5 and K_2O/ha was applied uniformly to all the experimental plots. Nitrogen was applied in four equal splits, one each at basal, active tillering panicle initiation and heading stages. The variety '*Vasundhara'* was used with nitrogen level of 120 kg/ha during both the years of the experiment. All the other cultural practices were followed as per the recommended package of practices.

The seed of rice was directly sown in lines in the non-puddled and non-flooded soil. The seed was treated with fungicide carbendazim 1 g/kg seed and then dibbled one seed/hill with a spacing of 20 x 10 cm. Thinning and gap filling were done at 10 DAS to maintain the uniform plant stand in all the plots. The data recorded on various growth and yield parameters of rice crop were analysed following standard statistical analysis of variance procedure as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The weed flora of experimental field consisted of seven species of grasses, three species of sedges and ten species of broadleaved weeds (BLW). Among the grasses, *Echinochloa crusgalli* was the predominant species followed by *Cynodon dactylon* and *Dactyloctenium aegypticum* (Table 1). Among the sedges, the dominant species was *Cyperus rotundus,* followed by *Cyperus difformis*. Among the BLW, *Celosia argentea* and *Cyanotis cucullata* were predominant during both the years of study. The density of weeds was influenced by irrigation schedules only at harvest during the first year and at 60 DAS and harvest of rice crop during the second year. At these stages, the lowest density of weeds and their dry weight were observed with irrigations scheduled at IW/CPE ratio of 1.2 (M^3), which were significantly lower than that with the other two irrigation schedules tried (Table 2).

Effect on weeds

The lowest density of grasses at 20 DAS was recorded with oxadiargyl 0.07 kg/ha supplemented with hand weeding (HW) at 40 DAS (S_3) during both the years of study. Pre-emergence application of triasulfuron 0.006 kg/ha along with HW at 40 DAS (S_5) was the next best treatment. The highest density of grasses was recorded with unweeded check (S_1), which was however, on par with hand weeding at 20 and 40 DAS (S_2) (hand weeding at 20 DAS was not imposed by that time). At 40, 60 DAS and at harvest, the lowest density of grasses at 40 DAS was recorded with hand weeding at 20 and 40 DAS (S_2) during both the years which was comparable with pre-emergence application of oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS (S_3) and both of them were significantly effective in suppressing grasses than with the rest of the treatments. Pre-emergence application of triasulfuron 0.006 kg/ha along with HW at 40 DAS (S_5) was in parity with pre-emergence application of bensulfuron-methyl 0.06 kg/ha with hand weeding at 40 DAS (S_4). The highest density of grasses was recorded with unweeded check (S_1).

At 20 DAS, the lowest broad leaved weeds (BLW) density among the weed management practices was recorded with pre-emergence application of triasulfuron 0.006 kg/ha along with HW at 40 DAS (S_5) during both the years. Oxadiargyl 0.07 kg/ha coupled with HW at 40 DAS (S_3) was the next best treatment followed by pre emergence application of bensulfuron-methyl 0.06 kg/ha coupled with hand weeding at 40 DAS (S_4). The highest BLW density was recorded with unweeded check (S_1), which was however on par with hand weeding at 20 and 40 DAS (S_2) (hand weeding at 20 DAS was not imposed by that time).

At 40, 60 DAS and at harvest the lowest BLW density among the weed management practices was recorded with hand weeding at 20 and 40 DAS (S_2) during both the years of study and was at par with the pre-emergence application of triasulfuron 0.006 kg/ha integrated with HW at 40 DAS (S_5). Oxadiargyl 0.07 kg/ha integrated with HW at 40 DAS (S_3) was comparable with the pre-emergence application of bensulfuron-methyl 0.06 kg/ha integrated with hand weeding at 40 DAS (S_4). The highest BLW density was recorded with unweeded check (S_1).

At 20 DAS the lowest sedge density was recorded with pre-emergence application of bensulfuron-methyl 0.06 kg/ha combined with hand weeding at 40 DAS (S_4) during both the years of study (Table 3). Pre-emergence

Table 1. Density of grasses/m^2 under aerobic culture rice as influenced by irrigation schedules and weed management practices

Treatment	2007				2008			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
Irrigation schedule								
M_1	63.78	65.70	46.87	63.21	80.29	82.10	60.72	73.12
	(8.02)	(8.14)	(6.88)	(7.98)	(8.99)	(9.09)	(7.82)	(8.58)
M_2	62.01	62.94	44.23	61.27	78.74	80.06	59.14	71.07
	(7.91)	(7.96)	(6.69)	(7.86)	(8.90)	(8.98)	(7.72)	(8.46)
M_3	59.06	63.23	42.37	54.14	77.44	78.03	54.78	64.00
	(7.72)	(7.98)	(6.55)	(7.39)	(8.83)	(8.86)	(7.44)	(8.03)
LSD (P=0.05)	NS	NS	NS	0.43	NS	NS	0.25	0.41
Weed management practice								
S_1	106.00	121.29	152.74	141.69	133.93	162.82	175.98	165.43
	(10.32)	(11.04)	(12.38)	(11.92)	(11.59)	(12.78)	(13.28)	(12.88)
S_2	95.34	22.64	14.14	19.56	133.56	32.33	23.50	29.68
	(9.79)	(4.81)	(3.83)	(4.48)	(11.58)	(5.73)	(4.90)	(5.49)
S_3	11.82	24.50	15.18	23.23	16.47	35.74	26.25	32.82
	(3.51)	(5.00)	(3.96)	(4.87)	(4.12)	(6.02)	(5.17)	(5.77)
S_4	66.25	82.07	20.85	64.00	71.22	90.42	33.15	68.00
	(8.17)	(9.09)	(4.62)	(8.03)	(8.47)	(9.54)	(5.80)	(8.28)
S_5	28.66	69.25	19.56	49.23	38.94	78.99	32.18	51.11
	(5.40)	(8.35)	(4.48)	(7.05)	(6.28)	(8.92)	(5.72)	(7.18)
LSD (P=0.05)	1.25	0.79	0.38	1.28	0.99	0.66	0.46	1.32

Figures in parentheses indicate square root transformed ($\sqrt{x+0.5}$) values

Table 2. Density of broad leaved weeds/m^2 under aerobic rice culture as influenced by irrigation schedules and weed management practices

Treatment	2007				2008			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At Harvest
Irrigation schedule								
M_1	21.92	30.75	18.91	22.53	27.53	36.22	24.00	26.41
	(4.73)	(5.59)	(4.41)	(4.80)	(5.29)	(6.06)	(4.95)	(5.19)
M_2	22.81	30.42	18.14	21.60	26.18	35.50	22.10	23.50
	(4.83)	(5.56)	(4.32)	(4.70)	(5.17)	(6.00)	(4.75)	(4.90)
M_3	20.96	29.41	17.41	17.44	25.34	34.43	19.17	15.16
	(4.63)	(5.47)	(4.23)	(4.24)	(5.08)	(5.91)	(4.44)	(3.96)
LSD (P=0.05)	NS	NS	NS	0.35	NS	NS	0.24	0.66
Weed management practice								
S_1	43.06	59.39	72.67	60.09	44.66	71.07	78.19	57.89
	(6.60)	(7.74)	(8.55)	(7.78)	(6.72)	(8.46)	(8.87)	(7.64)
S_2	35.02	16.23	3.87	8.19	39.70	20.02	6.84	10.00
	(5.96)	(4.09)	(2.09)	(2.95)	(6.34)	(4.53)	(2.71)	(3.24)
S_3	9.99	28.01	4.35	11.45	13.56	28.66	7.78	13.72
	(3.24)	(5.34)	(2.20)	(3.46)	(3.75)	(5.40)	(2.88)	(3.77)
S_4	18.42	30.19	5.84	13.19	29.93	33.26	8.95	15.67
	(4.35)	(5.54)	(2.52)	(3.70)	(5.52)	(5.81)	(3.07)	(4.02)
S_5	3.02	17.14	4.04	9.67	3.91	23.90	7.00	11.22
	(1.88)	(4.20)	(2.13)	(3.19)	(2.10)	(4.94)	(2.74)	(3.42)
LSD(P=0.05)	0.74	0.27	0.34	0.25	0.67	0.42	0.31	0.27

Figures in parentheses indicate square root transformed ($\sqrt{x+0.5}$) values

Table 3. Density of sedges/m^2 under aerobic rice culture as influenced by irrigation schedules and weed management practices

Treatment	2007				2008			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At Harvest
Irrigation schedule								
M_1	14.04	23.98	16.94	25.86	17.72	29.43	20.31	35.16
	(3.81)	(4.95)	(4.18)	(5.13)	(4.27)	(5.47)	(4.56)	(5.97)
M_2	14.50	23.35	16.48	24.60	16.86	28.78	19.33	34.10
	(3.87)	(4.88)	(4.12)	(5.01)	(4.17)	(5.41)	(4.45)	(5.88)
M_3	13.71	22.53	14.40	22.99	17.25	27.84	16.50	30.77
	(3.77)	(4.80)	(3.86)	(4.85)	(4.21)	(5.32)	(4.12)	(5.59)
LSD (P=0.05)	NS	NS	NS	0.14	NS	NS	0.23	0.23
Weed management practice								
S_1	32.74	53.82	61.76	70.34	39.95	47.18	57.51	70.89
	(5.77)	(7.37)	(7.89)	(8.42)	(6.36)	(6.91)	(7.62)	(8.45)
S_2	29.91	12.65	4.01	10.12	37.11	18.56	8.81	15.89
	(5.51)	(3.63)	(2.12)	(3.26)	(6.13)	(4.37)	(3.05)	(4.05)
S_3	3.21	22.46	4.60	14.66	4.26	37.11	9.10	29.80
	(1.93)	(4.79)	(2.26)	(3.89)	(2.18)	(6.13)	(3.10)	(5.50)
S_4	1.69	13.36	4.31	11.65	1.98	18.68	8.90	17.76
	(1.48)	(3.72)	(2.19)	(3.49)	(1.57)	(4.38)	(3.07)	(4.27)
S_5	2.87	14.15	5.05	15.65	3.07	21.88	9.25	32.32
	(1.84)	(3.83)	(2.36)	(4.02)	(1.89)	(4.73)	(3.12)	(5.73)
LSD (P=0.05)	0.28	0.37	0.25	0.35	0.30	0.36	0.28	0.54

Figures in parentheses indicate square root transformed ($\sqrt{x+0.5}$) values

Table 4. Total weed density/m^2 under aerobic rice culture as influenced by irrigation schedules and weed management practices

Treatment	2007				2008			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
Irrigation schedule								
M_1	99.74	120.43	82.72	111.60	125.54	147.75	105.03	134.99
	(10.01)	(11.00)	(9.12)	(10.59)	(11.23)	(12.18)	(10.27)	(11.63)
M_2	99.32	116.71	78.85	107.47	121.78	144.34	100.57	128.67
	(9.99)	(10.83)	(8.91)	(10.39)	(11.06)	(12.03)	(10.05)	(11.37)
M_3	93.73	115.17	74.18	94.57	120.03	140.30	90.45	109.93
	(9.71)	(10.75)	(8.64)	(9.75)	(10.98)	(11.87)	(9.54)	(10.51)
LSD (P=0.05)	NS	NS	NS	0.26	NS	NS	0.24	0.31
Weed management practice								
S_1	181.80	234.50	287.17	272.12	218.54	281.07	311.68	294.21
	(13.50)	(15.33)	(16.96)	(16.51)	(14.80)	(16.78)	(17.67)	(17.17)
S_2	160.27	51.52	22.02	37.87	210.37	70.91	39.15	55.57
	(12.68)	(7.21)	(4.75)	(6.19)	(14.52)	(8.45)	(6.30)	(7.49)
S_3	25.02	74.97	24.13	49.34	34.29	101.51	43.13	76.34
	(5.05)	(8.69)	(4.96)	(7.06)	(5.90)	(10.10)	(6.61)	(8.77)
S_4	86.36	125.62	31.00	88.84	103.13	142.36	51.00	101.43
	(9.32)	(11.23)	(5.61)	(9.45)	(10.18)	(11.99)	(7.17)	(10.10)
S_5	34.55	100.54	28.65	74.55	45.92	124.77	48.43	94.65
	(5.92)	(10.05)	(5.40)	(8.66)	(6.81)	(11.19)	(6.99)	(9.75)
LSD (P=0.05)	1.55	1.38	0.31	1.62	1.53	1.10	0.36	1.30

Figures in parentheses indicate square root transformed ($\sqrt{x+0.5}$) values application of triasulfuron 0.006 kg/ha along with HW at 40 DAS (S_5) was the next best treatment and was at par with oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS (S_3). The highest sedge density was recorded with unweeded check (S_1), which was however, on par with hand weeding at 20 and 40 DAS (S_2) (hand weeding at 20 DAS was not imposed by that time).

At 40, 60 DAS and at harvest, the lowest sedge density was recorded with hand weeding at 20 and 40 DAS (S_2) (hand weeding at 40 DAS was not imposed by that time), which was however, comparable with pre-emergence application of bensulfuron-methyl 0.06 Kg/ha integrated with hand weeding at 40 DAS (S_4) and pre-emergence application of triasulfuron 0.006 kg/ha integrated with HW at 40 DAS (S_5). All these treatments were significantly inferior to oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS (S_3). Unweeded check (S_1) recorded the highest sedge density.

The lowest total weed count at 20 DAS was recorded with oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS (S_3), which was comparable with pre-emergence application of triasulfuron 0.006 kg/ha integrated with HW at 40 DAS (S_5) and both of them were significantly lower than the rest of weed management practices studied (Table 4). Pre emergence application of bensulfuron methyl 0.06 kg/ha with hand weeding at 40 DAS (S_4) was the next best treatment. The highest total weed density was recorded with unweeded check (S_1), which was however, on par with hand weeding at 20 and 40 DAS (S_2) during both the years of study (hand weeding at 20 DAS was not imposed by that time).

The lowest total weed count at 40, 60 DAS and at harvest was recorded with hand weeding at 20 and 40 DAS (S_2) during both the years of study. Oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS (S_3), the next best treatment. Pre-emergence application of triasulfuron 0.006 kg/ha along with HW at 40 DAS (S_5) was at par with pre-emergence application of bensulfuron-methyl 0.06 kg/ha along with HW at 40 DAS (S_4). The highest total weed density was recorded with unweeded check (S_1).

WCE was not significantly influenced by irrigation schedules at any stage of growth during both the years of study (Table 5). The highest WCE at 20 DAS of crop was noticed with oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS (S_3) and at all the other stages it was recorded with hand weeding at 20 and 40 DAS (S_2) , which was comparable with oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS (S_3). The lowest WCE was recorded with unweeded check (S_1).

Effect on crop

Yield attributes *viz*., number of panicles/m^2 and number of filled grains/panicle were the highest with irrigation scheduled at IW/CPE ratio of 1.2 (M_3), which were significantly higher than with other two irrigation schedules tried. These parameters with irrigation scheduled at IW/CPE of 1.0 (M_2) were comparable with irrigation scheduled at IW/CPE ratio of 0.8 (M_1) which produced the lowest number of panicles/m^2 and number of filled grains/panicle. Within different weed management practices tried, hand weeding at 20 and 40 DAS (S_2) produced the highest number of panicles/m^2 and number of filled grains/panicle, which were, at par with pre-emergence application of oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS (S_3). Pre-emergence application of triasulfuron 0.006 kg/ha along with HW at 40 DAS (S_5) was comparable with pre-emergence application of bensulfuron-methyl 0.06 kg/ha with hand weeding at 40 DAS (S_4). The lowest values of these parameters were recorded with unweeded check (S_1) during both the years of study (Table 6).

The highest grain yield was recorded with the irrigations scheduled at IW/CPE ratio of 1.2 (M_3), which were significantly higher than with rest of the irrigation schedules tried. Irrigation scheduled at IW/CPE ratio of 1.0 (M_2) and 0.8 (M_1) were comparable with each other. Among the weed management practices, hand weeding at 20 and 40 DAS (S_2) recorded the highest grain yield and were comparable with pre-emergence application of oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS (S_3), which in turn were comparable with pre-emergence application of triasulfuron 0.006 kg/ha along with HW at 40 DAS (S_5). The next best treatment was pre-emergence application of bensulfuron-methyl 0.06 kg/ha with hand weeding at 40 DAS (S_4), which was comparable with pre-emergence application of triasulfuron 0.006 kg/ha along with HW at 40 DAS (S_5). The lowest grain yield was recorded with unweeded check (S_1) during both the years of study (Table 6).

The elevated stature of these parameters might be presumably due to the increased moisture content and thereby the effective translocation of photosynthates efficiently to sink, contributing to the better development of yield contributing characters These results are in conformity with those of Maheswari *et al.* (2007), Lin Xian Qing *et al.* (2005). The lowest stature of yield attributes of rice under aerobic culture was noticed with irrigation schedule at IW/CPE ratio of 0.8. Similar findings were reported by Belder *et al.* (2005). Grain yield of rice increased significantly with increase in irrigation schedule from 0.8 to

Table 5. WCE (%) at different stages of rice under aerobic culture as influenced by irrigation schedules and weed management practices

Treatment	2007				2008			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
Irrigation schedule								
M_1	50.35	66.94	75.01	63.06	49.87	64.86	69.94	59.67
M_2	50.50	67.79	75.21	63.14	50.22	65.06	72.05	59.57
M_3	50.70	67.89	76.01	65.02	50.55	65.44	75.81	62.92
Weed management practice								
S_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S_2	3.35	93.43	95.39	86.94	3.48	91.30	92.27	84.83
S_3	91.31	86.80	94.84	81.76	89.14	82.15	91.36	79.28
S_4	70.07	75.78	92.70	73.39	72.96	72.89	89.21	69.15
S_5	87.85	81.69	93.56	76.59	85.46	79.23	90.15	70.34

Table 6. Yield attributes and yield of rice under aerobic culture as influenced by irrigation schedules and weed management practices

Treatment	Panicles/m^2		Filled grains/ panicle		1000 - grain weight (g)		Grain yield (kg/ha)	
	2007	2008	2007	2008	2007	2008	2007	2008
Irrigation schedule								
M_1	147	145	117	112	23.42	23.13	4095	3957
M_2	149	146	121	118	23.82	23.41	4230	4073
M_3	161	158	133	132	23.91	23.79	4702	4547
LSD (P=0.05)	9	8	11	7	NS	NS	432	399
Weed management practice								
S_1	81	79	51	41	23.25	22.96	803	691
S_2	183	180	156	152	24.11	23.84	5761	5595
S_3	179	176	150	146	23.93	23.67	5561	5392
S_4	155	152	126	127	23.49	23.25	4530	4367
S_5	164	161	137	137	23.80	23.50	5055	4915
LSD (P=0.05)	16	15	13	10	NS	NS	674	648

1.2. The improvement in yield was due to better availability of moisture, which in turn lead to efficient physiological activity. High level of dry matter production and efficient translocation of photosynthates from source to sink might be responsible for the production of increased level of yield structure. Rice plants when grown under saturated condition, develop more plant stature, leaf area, root volume, productive tillers, resulting in higher yields. These results are in accordance with those of Jadhav *et al.* (2003), Singh *et al.* (2003) Ambrocio Castaneda *et al.* (2004) and Maheswari *et al.* (2007). The highest straw yield was observed with I_3, which was significantly superior to other levels and the lowest straw yields were associated with I_1.

Density of total weeds, grasses and BLWs increased up to 40 DAS and then decreased towards 60 DAS and again increased towards harvest of the crop. However, the rate of decrease was marginal. This might be due to the alternate wetting and drying conditions due to scheduling of irrigations based on IW/CPE ratio. However, the rate of increase of the density of sedges was more than grasses or BLWs towards the harvest of crop, indicating the ability of sedges to proliferate under wide varying conditions of soil moisture.

In general, the density of grasses was higher followed by BLWs and sedges. However, towards the later stages of crop growth, irrigations scheduled at IW/CPE ratio of 1.2, during both the years, resulted in significantly lesser total weed density including grasses, sedges and BLWs and their corresponding dry weights than with other irrigation schedules studied. This might be due to the favourable growing conditions created for crop growth upon the receipt of more irrigations than the other irrigation schedules, during both the years, which might have smothered the growth of weeds, thus depriving them of the basic growth resources and thereby resulting in reduced crop weed competition at later stages of crop growth. However, the WCE of all the irrigation schedules at all stages of crop growth were non significant. These results are in conformity with those of Samar Singh *et al.* (2008) and Subramanyam *et al.* (2007).

Weed management practices exerted significant influence on yield attributes of rice under aerobic rice *viz.*, number of panicles/m^2 and number of filled grains/panicle. The highest stature of the yield attributes was attained with the hand weeding at 20 and 40 DAS and pre-emergence application of oxadiargyl 0.07 kg/ha with hand weeding at 40 DAS. This may be attributed to the fact that effective weed management at critical stages of the crop weed competition, thereby the yield attributes were the highest with S_2. Similar results have been reported by Sharma *et al.* (2007) and Ramana *et al.* (2007).

The highest grain yield was obtained with hand weeding at 20 and 40 DAS and pre-emergence application of oxadiargyl 0.07 kg/ha with hand weeding at 40 DAS during both the years of investigation. This might be due to the fact that hand weeding at 20 and 40 DAS and pre emergence application of oxadiargyl 0.07 kg/ha with hand weeding at 40 DAS in rice under aerobic culture will reduce the weed competition and thereby there is improvement in yield attributes, resulting in higher grain yield. The superior performance of oxadiargyl could be attributed to the fact that it is a potent inhibitor of protox, deregulates the porphyrin pathway. Further to the action of chemical, the superior performance could also be attributed to the manual removal of existing vegetation without sparing any individual group of weeds through hand weeding at 40 DAS. These results are in accordance with those of Arul Chezhian and Kathiresan (2008), Rajkhowa *et al.* (2005) and Samar Singh *et al.* (2005).

In conclusion, the study revealed that rice can be successfully grown under aerobic culture in north coastal zone of Andhra Pradesh, with pre-emergence application of oxadiargyl 0.07 kg/ha supplemented with HW at 40 DAS for higher productivity.

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