Indian J. Weed Sci. **38** (1 & 2) : 37-41 (2006)

Effect of Puddling, Water and Weed Management Practices on Weed Dynamics and Yield of Transplanted Rice (*Oryza sativa* L.)

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ABSTRACT

The dominant weed flora were *Echinocloa colona* (L.), *Cyperus difformis* L. and *Ammania bracciferа* (L.) Rottb. Intensive puddling with continuous submergence recorded the lowest density and dry weight of weeds with 40% increased grain yield over normal puddling with irrigation at one day after disappearance of ponded water. Among the weed management practices, oxadiargyl at 75 g ha^{-1} supplemented with HW at 40 DAT recorded the lowest density and dry weight of weeds with higher weed control efficiency and grain yield, which was comparable with hand weeding twice scheduled at 20 and 40 DAT. On an average, oxadiargyl at 75 g ha^{-1} supplemented with HW at 40 DAT registered 39.5% higher grain yield as compared to unweeded control. Cinmethylin at 75 g ha^{-1} was least effective in controlling the weeds. Intensive puddling with continuous submergence combined with oxadiargyl at 75 g ha^{-1} supplemented with HW at 40 DAT was the best integrated weed management practice to achieve broad spectrum weed control and higher grain yield in transplanted rice.

INTRODUCTION

The productivity of rice should be substantially increased to meet the demand of the burgeoning human population through efficient and economically feasible crop management practices without damaging the basic resources of human survival viz., soil, water and air. Creative application of integrated agronomic management practices is one of the potential levers of phytosanitation aimed at optimum and favourable conditions for rice production and adverse environment for emergence and growth of weeds. Puddling operation followed by continuous submergence effectively suppresses the weeds. For the last many years, voluminous and high dose herbicides like butachlor, thiobencarb and anilifos are being applied as pre-emergence for effective control of weeds (Budha *et al.*, 1991). These herbicides effectively control the grassy weeds but less effective on sedges and some of the broad-leaved weeds. Continuous usage of same and voluminous herbicides may cause environmental pollution, development of resistance in weeds and shift of weed flora. Recent trend of herbicide use is to find out an effective weed control measure by using low dose high efficiency herbicides, which will not only reduce the total volume of the herbicides by 100 to 1000 times over conventional herbicides, but also the application becomes easier and economic (Kathiresan, 2001). Keeping this in view, the present study was undertaken to evaluate oxadiargyl and cinmethylin in combination with puddling and water management practices.

MATERIALS AND METHODS

The field experiment was carried out for two consecutive **rabi** seasons of 2003 and 2004 at S. V. Agricultural College Farm, Tirupati campus of Acharya N. G. Ranga Agricultural University, Andhra Pradesh. The soils were sandy clay loam in texture, slightly alkaline in reaction (pH 7.82), low in organic carbon (0.22%) and available nitrogen (179 kg ha^{-1}), high in available phosphorus (23.0 kg ha^{-1}) and potassium (184 kg ha^{-1}) with a bulk density of 1.30 g cm^{-3} and saturated hydraulic conductivity of 206 mm day^{-1}. The experiment was laid out in a split plot design and replicated thrice. The treatments comprised combination of four puddling and water management practices. Normal puddling with continuous submergence, normal puddling with irrigation at one day after disappearance of ponded water, intensive puddling with continuous submergence and intensive puddling with irrigation at one day after disappearance of ponded water were allotted to main plots and six weed management practices unweeded control, hand weedings at 20 and 40 days after transplanting, oxadiargyl at 75 g ha^{-1}, cinmethylin at 75 g ha^{-1}, oxadiargyl at 75 g ha^{-1} + HW at 40 DAT, cinmethylin at 75 g ha^{-1} + HW at 40 DAT were allotted to sub-plots. Intensive puddling plots were puddled twice with measured quantity of water, starting two weeks before transplanting with bose plough and these plots were again puddled twice with bose plough and once with bullock drawn wet land puddler one week before transplanting. Normal puddling plots were puddled twice with bose plough and once with bullock drawn wetland puddler one week before transplanting. Depth of land submergence was maintained as per the treatments by replenishing the daily water loss due to evapotranspiration and percolation. To drain out excess water from the plot, an over flow arrangement was provided for each plot by installing a brick outlet at 5 cm still well. Herbicides were applied as aqueous spray (600 l ha^{-1}) with the help of knapsack sprayer at 4th and 7th day after transplanting of rice, respectively. Twenty-eight days old seedlings of rice variety NLR-33359 (Sravani) were transplanted on November 9, 2003 and November 12, 2004. A uniform dose of 120-60-60 kg of N, P_2O_5 and K_2O ha^{-1} was applied. Half of the dose of nitrogen, full dose of phosphorus and potassium fertilizers were applied basally and half the dose of nitrogen was top dressed in two equal splits, at tillering and panicle initiation. The data on grasses, sedges and broad-leaved weeds and weed dry weight were taken at harvest and subjected to square root transformation to normalize their distribution.

RESULTS AND DISCUSSION

Effect on Weeds

Weed flora consisted of five species of grasses [*Echinochloa crusgalli* (L.) Beauv, *Echinochloa colona* (L.) Linn., *Digitaria sanguinalis* L., *Panicum repens* L. and *Cynodon dactylon* (L.) Pers.], three species of sedges (*Cyperus difformis* L., *Cyperus rotundus* L. and *Cyperus iria* L.) and five species of broad leaved weeds [*Eclipta alba* (L.) Hassk, *Ammania baccifera* (L.) Rottb, *Monochoria vaginalis* (Burm) Kurth, *Phyllanthus niruri* L. and *Commelina benghalensis* L.]. In unweeded control, the relative density of grasses, sedges and broad-leaved weeds was 34.9, 36.9 and 28.2%, respectively.

Among the puddling and water management practices tried, the broad spectrum weed control was obtained due to intensive puddling with continuous submergence, which was significantly superior to other puddling and water management practices in terms of weed density and dry weight followed by intensive puddling with irrigation at one day after disappearance of ponded water and normal puddling with continuous submergence (Table 1). On an average, the reduction in density and dry weight of weeds in intensive puddling with continuous submergence was 68.9% over normal puddling with irrigation at one day after disappearance of ponded water. This might be due to effective control of all categories of weeds during intensive puddling, which was started two weeks before transplanting and sufficient time allowed for germination of weed seeds present in the soil and in turn incorporated before transplanting during subsequent puddling. Further, continuous submergence after transplanting suppressed the weed seed germination due to lack of sufficient oxygen and reduced the growth and development of weeds. The total density including grasses, sedges and broad-leaved weeds and dry weight of weeds were the highest with normal puddling with irrigation at one day after disappearance of ponded

Table 1. Weed density (No. m^{-2}) and total weed dry weight (g m^{-2}) as influenced by puddling, water and weed management practices

Treatment	2003				2004			
	Grasses	Sedges	BLWs	Weed dry weight	Grasses	Sedges	BLWs	Weed dry weight
Puddling and water management								
Normal puddling with continuous	4.97	5.70	4.27	9.04	4.86	5.53	4.16	9.34
submergence	(28)	(37)	(21)	(92)	(26)	(35)	(19)	(99)
Normal puddling with irrigation at one day	6.22	5.72	5.69	11.94	5.94	5.60	5.45	11.42
after disappearance of ponded water	(45)	(38)	(37)	(157)	(41)	(36)	(34)	(143)
Intensive puddling with continuous	2.85	3.64	2.68	6.19	2.75	3.47	2.50	6.63
submergence	(9)	(15)	(7)	(43)	(8)	(13)	(6)	(40)
Intensive puddling with irrigation at one	4.36	4.57	3.80	8.09	4.20	4.38	3.58	8.35
day after disappearance of ponded water	(21)	(24)	(16)	(74)	(20)	(21)	(14)	(79)
LSD (P=0.05)	0.10	0.07	0.220	0.58	0.250	0.170	0.015	0.35
Weed management								
Unweeded control	7.59	7.90	6.81	13.52	7.31	7.62	6.51	13.78
	(61)	(64)	(49)	(190)	(56)	(60)	(45)	(195)
Hand weedings at 20 and 40 DAT	2.96	3.06	2.62	5.65	2.90	2.97	2.58	5.69
	(9)	(9)	(6)	(34)	(8)	(8)	(6)	(33)
Oxadiargyl at 75 g ha^{-1}	5.34	5.58	4.74	10.16	5.13	5.36	4.53	10.25
	(29)	(31)	(23)	(108)	(27)	(29)	(21)	(108)
Cinmethylin at 75 g ha^{-1}	6.17	6.88	5.36	11.68	5.91	6.65	5.12	11.87
	(40)	(48)	(30)	(142)	(37)	(45)	(27)	(145)
Oxadiargyl at 75 g ha^{-1} + HW at 40 DAT	2.39	2.66	2.28	5.24	2.33	2.58	2.11	5.41
	(6)	(6)	(5)	(29)	(5)	(6)	(4)	(30)
Cinmethylin at 75 g ha^{-1} + HW at 40 DAT	3.16	3.38	2.86	6.64	3.04	3.29	2.70	6.61
	(10)	(11)	(8)	(47)	(9)	(10)	(7)	(45)
LSD (P=0.05)	0.210	0.200	0.160	0.47	0.020	0.2 10	0.280	0.28

Figures in parentheses indicate original values.

Table 2. Grain yield (kg ha^{-1}) of rice as influenced by puddling, water and weed management practices

Weed management	Puddling and water management									
	2003					2004				
	NPCS	NPDDPW	IPCS	IPDDPW	Mean	NPCS	NPDDPW	IPCS	IPDDPW	Mean
Unweeded control	3601	3001	5050	4424	4019	3709	3166	5267	4600	4185
Hand weedings at 20 and 40 DAT	5224	4650	6010	5691	5394	5459	4845	6255	5918	5619
Oxadiargyl at 75 g ha^{-1}	4526	3916	5618	5289	4837	4707	4070	5848	5500	5031
Cinmethylin at 75 g ha^{-1}	4039	3401	5410	5050	4475	4200	3548	5634	5257	4660
Oxadiargyl at 75 g ha^{-1}+HW at 40 DAT	5459	4918	6110	5918	5610	5714	5114	6354	6155	5834
Cinmethylin at 75 g ha^{-1}+HW at 40 DAT	4995	4422	5887	5552	5214	5195	4605	6122	5775	5424
Mean	4647	4051	5681	5321		4830	4224	5913	5534	
			LSD (P=0.05)					LSD (P=0.05)		
Puddling and water management			425					386		
Weed management			266					270		
For comparing weed management at same or different puddling and water management practices			532					541		
For comparing puddling and water management at same or different weed management practices			570					561		

NPCS – Normal puddling with continuous submergence.
NPDDPW – Normal puddling with irrigation at one day after disappearance of ponded water.
IPCS – Intensive puddling with continuous submergence.
IPDDPW – Intensive puddling with irrigation at one day after disappearance of ponded water.

water due to oxidized conditions, which provide favourable environment for germination, growth and development of weeds.

Among the weed management practices, oxadiargyl at 75 g ha^{-1} supplemented with hand weeding at 40 DAT recorded significantly lesser density of all weeds and dry weight than rest of the weed management practices due to its higher weed control efficiency (85.3%), however, it was on par with hand weeding twice scheduled at 20 and 40 DAT. The reduction in weed density and dry weight in the former weed management practice was 89.9 and 84.5%, respectively, over unweeded control. Cinmethylin at 75 g ha^{-1} recorded the highest weed density and dry weight among the herbicide treated plots due to its poor weed control efficiency (26.0%) and least effective against sedges and some of the broad-leaved weeds. These results are in conformity with those of Gogoi (1998).

Grain Yield of Rice

The highest grain yield of rice was produced with intensive puddling with continuous submergence, which was comparable with intensive puddling with irrigation at one day after disappearance of ponded water and both of them were significantly superior to normal puddling with irrigation at one day after disappearance of ponded water (Table 2). On an average, the increased grain yield with intensive puddling with continuous submergence and intensive puddling with irrigation at one day after disappearance of ponded water was 40.1 and 31.2%, respectively, over normal puddling with irrigation at one day after disappearance of ponded water. This might be due to effective control of all groups of weeds. The highest grain yield was produced with oxadiargyl at 75 g ha^{-1} supplemented with hand weeding at 40 DAT, which was comparable with hand weeding twice at 20 and 40 DAT and both of them were significantly superior to other weed management practices. Kumar *et al.* (2004) also reported oxadiargyl to be very effective against complex weed flora in transplanted rice. The increase in grain yield with the former treatment was 39.5% over unweeded control. Cinmethylin at 75 g ha^{-1} recorded the lowest grain yield among the weed management practices except unweeded control due to poor weed control efficiency and severe competition for growth resources.

The interaction effect clearly showed that the highest grain yield of rice was recorded with oxadiargyl at 75 g ha^{-1} supplemented with hand weeding at 40 DAT or hand weeding twice scheduled at 20 and 40 DAT coupled with intensive puddling with continuous submergence. Among the herbicides treated plots, the lowest grain yield was recorded with cinmethylin at 75 g ha^{-1} in combination with normal puddling with irrigation at one day after disappearance of ponded water due to its poor weed control efficiency.

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