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Short communication

Weed management for enhanced production of aerobic rice

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Increasing scarcity of fresh water for agriculture particularly for rice cultivation due to demand of water to industries and other sectors, has threatened the sustainability of the irrigated rice ecosystem (Tuong and Bouman 2003). In this context, aerobic rice cultivation offers an opportunity to produce rice with less water. Aerobic rice system production saved irrigation water by more than half compared to flooded system and can possibly mitigate water scarcity in the future (Epino 2004). However, direct-seeded aerobic rice is subjected to more severe weed infestation than transplanted rice because in aerobic rice system, weeds germinate simultaneously with rice and there is no water layer to suppress the weed growth. *Cynodon dactylon*, *Chloris barbata*, *Dactyloctenium aegyptium*, *Digitaria sangunalis*, *Echinochloa colona*, *Eleusine indica* and *Panicum repens* among the grasses; *Alternanthra pungens*, *Cleome viscosa*, *Cleome chelidoni*, *Eclipta alba*, *Euphorbia hirta*, *Ludwigia parviflora*, *Parthenium hysterophorus*, *Phyllanthus niruri*, *Portulaca olerace* and *Tridax procumbens* among the broad-leaved weeds; *Cyperus rotundus* and *Cyperus iria* among the sedges were reported to be the major weed flora of aerobic rice from different parts of India (Musthafa and Potty 2001, Moorthy and Sanjoy Saha 2002, Ramesh *et al*. 2009). Weeds are the greatest constraint to yield in upland or aerobic rice systems, resulting in yield losses between 30 and 98% (Oerke and Dehne 2004). Considering the above facts, a field experiment was conducted to evaluate the efficacy of different weed management practices in managing weeds of aerobic rice in the coastal region of Karaikal, Puducherry.

A field experiment was conducted during *kharif* 2011 at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry. The soil of the experimental site was loamy sand in texture and pH was slightly acidic (6.1). The fertility status of the soil was low in available nitrogen (78.4 kg/ha) and phosphorus (16.2 kg/ha) and medium in available potassium (138 kg/ha). The organic carbon content was medium (0.76%). A early maturing (107 to 117 days) rice cv. '*PMK(R) 3*' with medium fine grain quantity, was sown in June at a spacing of 20×10 cm. The experiment consisted of 11 treatments, *viz.* pendimethalin 0.75 kg/ha + hand hoeing (HH) at 40 days after seeding (DAS), cyhalofop 0.10 kg/ha + HH at 40 DAS, pretilachlor + safener 0.50 kg/ha + HH at 40 DAS, pyrazosulfuron ethyl 0.20 kg/ha + HH at 40 DAS, butachlor 1.00 kg/ha+ HH at 40 DAS, anilophos0.40 kg/ha + HH at 40 DAS, metamifop 0.075 kg/ha + HH at 40 DAS, metamifop 0.100 kg/ha + HH at 40 DAS, hand hoeing at 20 and 40 DAS, and unweeded control. The aerobic rice under these treatments was compared with transplanted rice given two hand weedings at 20 and 40 days after transplanting (DAT). The experiment was laid out in a randomized block design with three replications. Pre-emergence herbicides were applied at three days after sowing and early post-emergence herbicides were applied at twelve days after sowing. A quadrat of size 0.25 m^2 was placed in the sampling area of each plot and weeds falling within the frames of quadrat were counted and recorded. These weeds were removed, washed free of soil and oven dried at 70°C for 72 hours and the weed biomass was recorded at 30, 60 and 90 DAS and at harvest. Weed index was caluculated using the formula given by Gill and Vijaykumar (1969). The weed control efficiency was calculated using the following formula (Mani *et al.* 1973). The plant height (cm) at harvest was measured from the bese to tip of fully emerged leaf. At harvest, rice plants from randomly selected five hills in the sampling area were uprooted, washed free of soil and shade dried. Later they were oven dried at 70°C for 72 hours and the rice biomass was recorded. The yield attributes of rice such as number of productive tillers/hill, panicle weight, grians/panicle and test weight were also recorded. Since the data on weed density and weed biomass showed high variation, the data were subjected to square root transformation using.

The predominant weed flora included grasses *Echinochloa colona*, *Cynodon dactylon*; *Panicum repens*

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and broad-leaved weeds such as *Trianthema portulacastrum, Cleome viscosa, Aeschynomene indica* and *Eclipta alba*. *Cyperus rotundus* was the only sedge noticed. The grasses constituted major portion (74.8 %) of the weed flora.

The weed management practices significantly influenced the weed density and dry weight at different stages of aerobic rice (Tables 1 and 2). Pre-emergence application of pendimethalin 0.75 kg/ha + HH at 40 DAS recorded the lower weed density and weed dry weight at 30 DAS. This could be attributed to the reason that pendimethalin is effective against *Trianthema portulacastrum* which was the predominant weed at initial stages of the crop growth. Anilophos 0.40 kg/ha + HH at 40 DAS recorded lowest weed density at later stages as anilophos controlled *Echinochloa colona* which predominated the experimental field at later stages of crop growth.

Weed control efficiency varied with different weed management practices in aerobic rice. At 30 DAS, weed control efficiency ranged from 27.8% in metamifop 0.075 kg/ha + HH at 40 DAS to 77.4% in pendimethalin 0.75 kg/ha + HH at 40 DAS (Table 3) indicating the superiority of pendimethalin 0.75 kg/ha + HH during critical period of crop weed competition. Similar observations were made by Ramesh *et al.* (2009) in aerobic rice.

Uncontrolled weeds reduced aerobic rice yield by 90.3%. All the weed control treatments substantially reduced the competition by weeds for various resources resulting in lower weed index. Anilophos 0.40 kg/ha+ HH recorded the least weed index (4.1) followed by butachlor 1.00 kg/ha + HH (21.0) and hand hoeing at 20 and 40 DAS (22.7).

Pendimethalin 0.75 kg/ha + HH at 40 DAS recorded higher plant height, leaf area and biomass of rice (Table 4). Among the weed control treatments, pendimethalin 0.75 kg/ha + HH at 40 DAS followed by anilophos 0.40 kg/ha + one hand hoeing at 20 and 40 DAS and butachlor 1.00 kg/ha+ one HH, recorded higher rice yield components like productive tillers per hill, panicle weight, number of grains/panicle and test weight. These treatments were on par with each other for almost all yield attributes (Table 4), since the degree of weed control achieved by these treatments were more or less similar (Table 3). The unweeded control recorded the lowest values for all yield components.

Among different weed control treatments, pendimethalin 0.75 kg/ha + HH at 40 DAS registered significantly higher grain (1.53 t/ha) and straw yields (2.74 t/ha). It was observed that in aerobic rice, the grain yield could be increased by 5.5 to 10.4 times and the straw yield by 2.0 to 3.4 times when weeds were effectively controlled. This may be attributed to enhanced availability of nutrients, soil moisture and other resources due to effective weed control by herbicides during early stages as reported by Singh *et al.* (2005). It was also observed that transplanted rice recorded 28% higher grain yield than the best treatment in aerobic rice *i.e.* pendimethalin 0.75 kg/ha + HH at 40 DAS.

Table 1. Total weed density (no./m^2) at various growth stages of aerobic rice as influenced by different weed control treatments

Treatment	Seedling stage (30 DAS)	Vegetative stage (60 DAS)	Flowering stage (90 DAS)	Harvest stage
T_1 - Pendimethalin 0.75 kg/ha + HH at 40 DAS	6.9 (47.7)	6.0 (35.0)	6.2 (37.7)	6.4 (40.3)
T_2 - Cyhalofop 0.10 kg/ha + HH at 40 DAS	14.3 (205.3)	7.4 (54.3)	7.8 (61.0)	5.7 (32.3)
T_3 - Pretilachlor + safener 0.50 kg/ha + HH at 40 DAS	13.9 (195.0)	5.8 (33.3)	7.8 (61.0)	6.8 (46.3)
T_4 - Pyrazosulfuron ethyl 0.20 kg/ha + HH at 40 DAS	15.5 (240.7)	7.3 (53.3)	8.9 (78.3)	5.2 (26.3)
T_5 - Butachlor 1.00 kg/ha + HH at 40 DAS	12.2 (147.3)	7.0 (43.0)	7.4 (54.3)	8.5 (72.0)
T_6 - Anilophos 0.4 kg/ha + HH at 40 DAS	13.9 (192.0)	5.2 (27.0)	6.0 (35.3)	6.4 (41.0)
T_7 - Metamifop 0.075 kg/ha + HH at 40 DAS	15.0 (224.3)	6.0 (35.0)	7.4 (55.0)	6.4 (40.0)
T_8 - Metamifop 0.10 kg/ha + HH at 40 DAS	13.5 (181.0)	6.2 (38.3)	7.4 (54.3)	7.0 (48.0)
T_9 - Hand hoeing at 20 and 40 DAS	14.1 (199.3)	6.7 (44.3)	6.3 (39.0)	7.0 (48.0)
T_{10} - Unweeded Control	17.1 (299.4)	17.8 (315.7)	14.4 (207.3)	12.7(161.0)
T_{11} - Transplanted rice with HW at 20 and 40 DAT	4.0 (10.3)	3.5 (11.7)	3.5 (11.7)	2.3 (5.0)
LSD (P=0.05)	0.98	0.76	0.81	0.55

Figures in parentheses indicate original values

Table 2. Total weed biomass (g/m^2) at various growth stages of aerobic rice as influenced by different weed control treatments

Treatment	Seedling stage (30 DAS)	Vegetative stage (60 DAS)	Flowering stage (90 DAS)	Harvest stage
T_1	4.2 (24.9)	3.3 (10.7)	5.2 (26.9)	6.3 (39.9)
T_2	8.5 (72.0)	3.8 (13.9)	6.1 (37.1)	7.1 (50.5)
T_3	8.1 (65.1)	3.1 (9.0)	5.1 (25.4)	5.9 (34.6)
T_4	8.4 (69.7)	3.1 (9.2)	5.3 (27.3)	8.3 (69.1)
T_5	7.7 (59.6)	3.7 (13.3)	6.8 (45.7)	8.1 (65.9)
T_6	7.1 (50.3)	2.8 (7.4)	6.0 (36.1)	8.1 (65.1)
T_7	9.1 (79.6)	3.4 (11.1)	5.9 (33.8)	6.2 (28.4)
T_8	8.4 (70.0)	3.4 (11.9)	6.8 (45.4)	6.1 (38.4)
T_9	5.6 (30.6)	2.8 (7.4)	5.6 (30.8)	6.6 (37.3)
T_{10}	10.5 (110.3)	12.1 (144.7)	13.0 (170.6)	13.7 (187.9)
T_{11}	2.7 (6.7)	2.0 (3.7)	1.9 (3.0)	1.6 (2.1)
LSD (P=0.05)	0.91	0.46	0.55	0.77

Figures in parentheses indicate original values; Treatment details are given in Table 1

Table 3. Weed control efficiency at various growth stages and weed index as influenced by different weed control treatments in aerobic rice

Treatment	Weed control efficiency+				Weed Index+
	30 DAS	60 DAS	90 DAS	Harvest stage	
T_1	77.4	92.6	84.2	78.8	-
T_2	34.7	90.4	78.2	73.1	37.2
T_3	41.0	93.4	85.1	81.6	36.0
T_4	36.8	93.6	84.0	63.2	28.7
T_5	46.0	90.8	73.2	64.9	21.0
T_6	54.4	94.9	78.8	65.4	4.1
T_7	27.8	92.8	80.1	84.9	43.2
T_8	36.5	91.8	73.4	79.4	47.1
T_9	72.3	94.9	81.9	80.1	22.7
T_{10}	-	-	-	-	90.3
T_{11}	93.9	97.4	98.2	98.9	-28.0

+ Data statistically not analysed; Treatment details are given in Table 1

Pre-emergence application of pendimethalin at 0.75 kg/ha followed by one hand hoeing at 40 DAS was found most suitable weed management practice for achieving higher weed control efficiency and grain yield of aerobic rice in Karaikal region of Puducherry.

SUMMARY

A field experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry to evaluate the efficacy of different weed management practices in managing weeds of aerobic rice in the coastal areas of Karaikal. The experiment involved eleven weed management treatments laid out in randomized block design with three replications. Treatments included: four pre-emergence (pendimethalin 0.75 kg/ha, pretilachlor + safener 0.50 kg/ha, Butachlor 1.00 kg/ha and anilophos 0.40 kg/ha) and three early post-emergence herbicides (cyhalofop 0.10 kg/ha, pyrazosulfuron ethyl 0.20 kg/ha, metamifop 0.075 kg/ha, metamifop 0.100 kg/ha) followed by one hand hoeing

Table 4. Aerobic rice growth parameters, yield components and yield as influenced by different weed control treatments

Treatment	Plant height (cm)	Leaf area index	Rice biomass (g/plant)	No of productive tillers/hill	Panicle weight (g)	No of grains/ panicle	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1	137.7	7.25	25.95	11.9	3.9	128.0	25.5	1533	2741
T_2	108.3	6.16	18.16	6.9	2.8	87.3	21.5	963	1778
T_3	126.9	5.55	22.48	8.1	3.0	98.3	22.1	981	1778
T_4	121.8	6.01	24.04	8.3	3.1	101.3	22.2	1093	2111
T_5	122.5	5.45	25.32	9.4	3.2	106.7	22.7	1211	1963
T_6	133.5	6.53	25.60	10.5	3.3	113.7	23.5	1470	2778
T_7	108.8	4.52	18.30	7.9	3.0	95.7	21.9	870	1611
T_8	100.1	5.04	15.21	5.9	2.8	71.0	21.3	811	1415
T_9	113.6	6.85	25.11	9.0	3.1	103.0	22.6	1185	2389
T_{10}	96.7	4.40	10.92	3.1	2.6	65.0	16.8	148	815
T_{11}	145.7	7.53	36.49	13.8	4.0	161.3	26	1963	4185
LSD (P=0.05)	13.5	1.13	3.75	1.5	0.5	17.5	4.2	162	344

at 40 DAS. Aerobic rice under these treatments was compared with transplanted rice given two hand weeding at 20 and 40 days after transplanting. The predominant weed flora observed in the experimental field were *Echinochloa colona, Cynodon dactylon, Panicum repens, Cyperus rotundus, Trianthema portulacastrum, Cleome viscosa, Aeschynomene indica* and *Eclipta alba.* Herbicides tested were effective in reducing the weed density and biomass and increasing the rice grain yield significantly. Pre-emergence application of pendimethalin 0.75 kg/ha + HH at 40 DAS recorded significantly higher grain and straw yields with lower weed density, weed biomass and higher weed control efficiency.

REFERENCES

Bouman BAM, Xiaoguang Y, Huaqui W, Zhiming W, Junfang Z, Changgui W and Bin C. 2002. Aerobic rice (Han Dao): A new way of growing rice in water short areas. pp. 175–181. In: *Proceedings of the 12th International Soil Conservation Organization Conference,* May 26-31, Beijing, China, Tsinghua University .

Epino MR. 2004. Aerobic rice technological available in the Philippines. Seed Quest. Central Information Website for the global seed industry. *Oryza* **56**: 256–258

Gill VS and Vijaykumar. 1969. Weed Index - A new method of reporting weed control trials. *Indian Journal of Agronomy* **14**(1): 96–98.

Mani VS, Malla ML, Gautam KC and Bhagavandas. 1973. Weed killing chemicals in potato cultivation. *Indian Farming* **23**(8):17–18.

Moorthy BTS and Sanjoy Saha. 2002. Evaluation of pre and post-emergence herbicides for their effects on weeds and upland direct seeded rice. *Indian Journal of Weed Science* **34**(3&4): 197–200.

Musthafa K and Potty NN. 2001. Effect of *in situ* green manuring on weeds in rice seeds dibbled semi dry rice. *Journal of Tropical Agriculture* **39**: 172–174.

Oerke EC and Dehne HW. 2004. Safeguarding production losses in major crops and the role of crop protection. *Crop Protection* **23**: 275–285.

Ramesh T, Sathiya K, Padmanaban PK and James Martin G. 2009. Optimization of nitrogen and suitable weed management practice for aerobic rice. *Madras Agriculture Journal* **96**(7-12): 344–348.

Singh VP, Govindra Singh, Singh RK, Singh SP, Abnish Kumar, Dhayani VC, Kumar M and Sharma G. 2005. Effect of herbicides alone and in combination on direct seeded rice. *Indian Journal of Weed Science* **37**: 197–201.

Tuong T and Bouman BAM. 2003. Rice production in water-scarce environments. pp. 53–67.In: W*ater Productivity in Agriculture: Limits and Opportunities for Improvement.*(Eds. Kijne JW, Barker R, Molden D). CABI Publishing, UK