Indian Journal of Weed Science **45**(1): 7–11, 2013

Integrated weed management practices on growth and yield of direct-seeded lowland rice

T. Parthipan*, V. Ravi and E. Subramanian

Rice Research Institute, Tamil Nadu Agricultural University, Aduthurai, Tamil Nadu 612 101

Received: 8 January 2013; Revised: 29 March 2013

ABSTRACT

Field experiments were conducted to find out the effect of integrated weed management practices on growth and yield of direct seeded rice in Cauvery delta zone. Twelve weed control treatments were tested in randomised block design replicated thrice. The treatments consisted of post-emergence application of metamifop (75, 100, 125 g/ha), pre emergence application of pretilachlor + safener 0.45 kg/ha alone and their combination with one hand weeding at 45 DAS. In addition, post-emergence metamifop 200 g/ha and cyhalofop-butyl 100 g/ha alone was also tested along with two hand weeding at 25 and 45 DAS and unweeded control. The results revealed that two hand weeding was found to be better in terms of weed control and grain yield of rice over other weed management practices. Among the herbicides, the pre-emergence application of pretilachlor + safener 0.45 kg/ha followed by one hand weeding at 45 DAS was effective in controlling all weeds and registered higher yield attributes and yield in wet-seeded rice which was at par with two hand weeding. Greater reduction in grass weed population was observed with post-emergence application of metamifop 100 and 125 g/ha as compared to other herbicides. Pre-emergence application of pretilachlor + safener 0.45 kg/ha followed by one hand weeding at 45 DAS was found to be ideal weed management practice for improving the rice grain yield by eliminating crop-weed competition in wet-seeded rice.

Key words: Growth, Integrated weed control, Weed density, Wet-seeded rice, Yield

Meeting food demand for the increasing population has become a major challenge now than ever before. Agriculture is in the forefront of national and international agenda to assume food security through sound management of natural resources. Cereals play major role in our food economy and it is the most important part of diet throughout the world. Amongst cereals, rice *(Oryza sativa*) is the most important and extensively grown crop in tropical and subtropical regions of the world as it is staple food for more than 60% of the world population.

Rice production systems are undergoing several changes and one of such changes is shift from transplanted rice to direct seeding. Direct seeding offers certain advantages *i.e*. saves labour, faster, easier, timely sowing, less drudgery, early crop maturity by 7–10 days, less water requirements, higher tolerance to water deficit, often higher yield, low production cost, more profit, better soil physical conditions for following crops and less methane emission (Balasubramanian and Hill 2002). Despite several advantages, various production obstacles are also encountered in direct seeded rice (DSR) cultivation.

***Corresponding author:** parthiagri@yahoo.co.in

The productivity of rice in India is declining due to an array of biotic and abiotic factors. Weeds are the prime yield-limiting biotic constraints that compete with rice for moisture, nutrients, and light. Weed infestation and competition are severe in puddled direct-seeded rice as compared to transplanted rice, because of the simultaneous growth of both crops and weeds. Weed competition reduced the grain yield by 50-60% in direct-seeded low land rice (Subramanian 2011). Any delay in weeding will lead to increased weed biomass which has a negative correlation with yield. Herbicides presently used in rice are mainly pre-emergence and weeds coming at later stages of crop growth are not controlled by these herbicides. No single approach, either uses of herbicides or manual/mechanical weeding is convenient in containing the weed menace. Hence, the present investigation was carried out to study the effect of integrated weed management packages for control of weeds in direct seeded rice.

MATERIALS AND METHODS

Field experiments were conducted at Tamil Nadu Rice Research Institute (Tamil Nadu Agricultural University), Aduthurai during wet seasons of 2011 and 2012 to study the effect of integrated weed management prac-

tices for weed control in direct seeded lowland rice in Cauvery Delta Zone of Tamil Nadu. The soil of the experimental field was clay with slightly alkaline pH (8.2), medium in organic carbon (0.52%), low in available nitrogen (161 kg/ha), high in available phosphorus (54.5 kg/ha) and medium in available potassium (206 kg/ha). A total of 12 treatments was tested in a randomized block design replicated thrice. The treatments consisted of post-emergence application of metamifop (75, 100, 125 g/ha), pre-emergence application of pretilachlor + safener 0.45 kg/ha alone and their combination with one hand weeding at 45 DAS. Post-emergence metamifop 200 g/ha and post-emergence cyhalofop-butyl 100 g/ha alone was also tested along with two hand weeding at 25 and 45 DAS and unweeded control for weed control and productivity in direct-seeded rice.

Long duration (155 days) high yielding variety '*CR 1009*' was sown during 11.08.2011 and 15.08.2012 with pre-germinated rice seeds by using drum seeder with inter and intra row spacing of 20 x 7.5-10 cm respectively. The crop was fertilized with recommended dose of 150: 50: 50 kg of N, P_2O_5, K_2O/ha and entire dose of phosphorus was applied as basal in addition to zinc sulphate 25 kg/ha and gypsum 500 kg/ha. Nitrogen and potassium were applied in four equal splits at 21 DAS, active tillering, panicle initiation and heading stages. Pre-emergence herbicide was mixed with sand and applied uniformly in the field on 3 DAS. The post-emergence herbicides were mixed with water at the rate of 500 litres/ha and sprayed at 2-3 leaf stage of weeds by using knapsack sprayer fitted with deflector nozzle. A thin film of water was maintained at the time of pre-emergence herbicide application. Hand weeding was carried out as per the treatment schedule. All other agronomic and plant protection measures were adopted as per the recommended packages.

The data on weed density (30, 60 DAS and harvest) and weed dry weight (60 DAS) were recorded with the help of a quadrate (0.5 x 0.5 m). In case of observation on weeds, normality of distribution was not seen and hence, the values were subjected to square root transformation ($\sqrt{x+0.5}$) prior to statistical analysis to normalize their distribution. Observations on crop growth parameters, *viz.* plant height (harvest), leaf area index (90 DAS) and yield attributes like panicles/m^2, grains per panicle and grain yield were recorded. The weed control efficiency was worked out on the basis of weed dry matter production using the formula suggested by Mani *et al.* (1973) and weed index was calculated by using the formula suggested by Gill and Vijayakumar (1966).

RESULTS AND DISCUSSION

Weed flora

The important weed species observed in the experimental fields were: *Echinochloa crusgalli, Echinochloa colona, Leptochloa chinensis* and *Panicum repens* among grasses; *Cyperus difformis, Cyperus iria* and *Fimbristylis miliacea* among sedges; and *Marselia quadrifolia, Eclipta alba, Ammania baccifera, Bergia capensis* and *Ludwigia parviflora* among broad-leaved weeds.

Effect on weeds

The density and dry weight of weeds were significantly influenced by weed control treatments at all stages of observation in both the years of study (Table 1 and 2). The minimum weed density (22.3, 23.3; 26.3, 17.0 and 43.3, 24.7 no./m^2) at 30, 60 DAS and harvest stages and weed dry weight (7.9, 7.6 g/m^2) at 60 DAS were recorded under two hand weeding on 25 and 45 DAS during both years respectively. This was found to be on par with pre-emergence application of pretilachlor + safener 0.45 kg/ha on 3 DAS followed by one hand weeding on 45 DAS and post emergence application of metamifop 100, 125, 200 g/ha followed by one hand weeding on 45 DAS during two years of study at both 60 DAS and harvest. At 30 DAS, the density and dry weight of weeds were lower under two hand weeding over rest of the treatments. These findings were in conformity with Prasad *et al.* (2001) who reported that hand weeding twice resulted in lower weed density and dry weight compared to herbicide application and untreated control. As hand weeding is laborious, tedious, expensive and time consuming method, it can not be practicable at large scale.

Among herbicides, pretilachor + safener was found to be efficient in reducing population of sedges and broad-leaved weeds, but grass weed population was markedly reduced by the application of metamifop. This may be due to the fact that pretilachlor + safener effectively controlled early flushes of weeds and later flushes of weeds by hand weeding. These results were in agreement with the findings of Sangeetha (2009) and Chinnusamy *et al.* (2010). Among different dose of application, metamifop at 100, 125 and 200 g/ha showed higher reduction of grass weed as compared to metamifop at 75 g/ha. The results further revealed that maximum weed density was noticed in untreated plots during both the years. It clearly shows that non adoption of proper weed control measures leads to constant increase in density and dry weight of weeds as a result, crop growth and establishment suffer severely.

At 60 DAS, two hand weeding on 25 and 45 DAS and application of herbicides supplemented with one hand

Table 1. Influence of weed management practices on total weed density (no./m²) in direct-seeded rice

Treatment	30 DAS		60 DAS		Harvest	
	2011	2012	2011	2012	2011	2012
Metamifop 75 g/ha	11.6	12.8	12.7	14.4	13.3	14.1
	(133.3)	(164.0)	(161.3)	(207.3)	(175.67)	(197.7)
Metamifop 100 g/ha	11.1	12.1	12.5	13.2	12.5	13.4
	(123.67)	(147.3)	(156.0)	(175.3)	(156.0)	(178.7)
Metamifop 125 g/ha	10.7	12.3	12.2	13.3	12.1	13.1
	(113.7)	(151.0)	(148.7)	(176.0)	(146.0)	(170.3)
Metamifop 200 g/ha	10.7	12.3	11.9	13.0	12.2	13.0
	(114.0)	(150.3)	(142.7)	(169.3)	(148.3)	(170.0)
Pretilachlor + safener 450 g/ha	8.7	9.6	10.9	11.3	11.6	11.1
	(77.3)	(92.0)	(118.0)	(128.0)	(134.0)	(124.0)
Cyhalofop-butyl 100 g/ha	11.5	12.7	12.8	14.3	13.1	13.8
	(131.3)	(162.3)	(163.7)	(203.0)	(172.7)	(190.7)
Metamifop 75 g/ha + HW 45 DAS	11.1	12.1	5.4	5.4	7.1	6.4
	(121.7)	(145.3)	(29.0)	(28.3)	(50.7)	(40.3)
Metamifop 100 g/ha + HW 45 DAS	11.0	12.0	5.5	4.9	7.0	6.0
	(121.7)	(144.0)	(30.3)	(23.3)	(48.0)	(35.7)
Metamifop 125 g/ha + HW 45 DAS	11.0	11.9	5.4	4.7	6.3	5.6
	(121.3)	(142.3)	(28.7)	(22.0)	(39.3)	(31.0)
Pretilachlor + safener 450 g/ha + HW 45 DAS	8.1	9.3	5.3	4.7	6.6	5.4
	(65.3)	(85.7)	(27.7)	(22.0)	(42.7)	(28.33)
Hand weeding twice - 25 and 45 DAS	4.8	4.9	5.2	4.2	6.6	5.0
	(22.3)	(23.3)	(26.3)	(17.0)	(43.3)	(24.7)
Unweeded control	13.3	15.1	15.2	16.9	16.7	17.7
	(177.3)	(227.0)	(232.0)	(284.3)	(280.0)	(312.0)
LSD (P=0.05)	1.0	0.9	0.9	0.9	0.9	0.8

Figures in parentheses are original values, which were subjected to square root transformation ($\sqrt{x + 0.5}$) before analysis

Table 2. Influence of weed management practices on weed dry weight, weed control efficiency and weed index at 60 DAS in direct-seeded rice

Treatment	Weed dry weight (g/m²)		Weed Index (%)		WCE (%)	
	2011	2012	2011	2012	2011	2012
Metamifop 75 g/ha	10.2(103.3)	10.8 (115.9)	45.2	57.1	58.2	53.4
Metamifop 100 g/ha	9.6 (91.8)	10.1 (101.2)	38.3	51.5	62.8	59.3
Metamifop 125 g/ha	9.3 (87.0)	10.0 (98.8)	35.9	50.0	64.8	60.3
Metamifop 200 g/ha	9.2 (83.8)	9.4 (88.4)	33.6	48.8	66.0	64.5
Pretilachlor + safener 450 g/ha	8.9 (78.5)	8.8 (77.7)	31.3	47.0	68.2	68.8
Cyhalofop-butyl 100 g/ha	10.51(110.2)	10.6 (112.9)	41.5	53.0	55.4	54.6
Metamifop 75 g/ha + HW 45 DAS	3.81 (14.1)	4.4 (18.8)	16.5	16.3	94.3	92.4
Metamifop 100 g/ha + HW 45 DAS	3.65 (12.9)	4.0 (15.3)	9.1	7.1	94.8	93.8
Metamifop 125 g/ha + HW 45 DAS	3.56 (12.2)	4.0(15.7)	8.7	3.4	95.0	93.7
Pretilachlor + safener 450 g/ha+ HW 45 DAS	3.00 (8.5)	2.9 (8.1)	4.0	2.0	96.5	96.7
Hand weeding twice - 25 and 45 DAS	2.87 (7.9)	2.8 (7.6)	0.0	0.0	96.8	96.9
Unweeded control	15.73(246.9)	15.8 (248.8)	63.4	70.5	0.0	0.0
LSD (P=0.05)	0.56	0.70	-	-	-	-

Figures in parentheses are original values, which were subjected to square root transformation ($\sqrt{x + 0.5}$) before analysis

weeding at 45 DAS recorded more than 90% weed control efficiency as compared to herbicides application alone which recorded WCE of 53-68%. These observations indicated that weeds in DSR could be kept at low level by integrating chemical and physical methods of weed control. Similar results were also reported by Sinha *et al.* (2006) and Singh *et al*. (2009).

Effect on crop growth

All the weed control treatments brought out a significant effect on plant height and leaf area index (Table 3). Plant height and leaf area index (LAI) were found to be the lowest in weedy check and maximum in two hand weeding on 25 and 45 DAS as reported by Singh *et al.* (2012). Taller rice plants were observed in the plots given with two hand weeding (113.7 and 127.2 cm) which was at par with herbicide application supplemented with one hand weeding at 45 DAS, whereas shorter plants were observed with application of herbicides alone and unweeded check. Maximum LAI of 7.85 and 8.95 were recorded under two hand weeding which was at par with pre-emergence application of pretilachlor + safener 0.45 kg/ha on 3 DAS followed by one hand weeding at 45 DAS and this was found superior over rest of the treatments during both the years. This might be due to effective control of weeds, less crop-weed competition throughout the crop growth period and crop enjoyed favourable conditions with respect to light, space, nutrients, CO_2 *etc*. These results are in conformity with the findings of Subramanian *et al.* (2006) who reported that the weed management practices adopted in wet-seeded rice, improved the growth parameters by eliminating crop-weed competition at critical stages.

Effect on yield

Yield contributing characters like panicles per square metre, grains per panicle and grain yield were significantly influenced by the weed control practices in DSR (Table 3). Among the treatments, two hand weeding registered the highest number of panicles 368 and 409/m^2 during both the year, respectively, which was at par with the pre-emergence application of pretilachlor + safener 0.45 kg/ha on 3 DAS followed by one hand weeding at 45 DAS and metamifop 125 g/ha followed by one hand weeding at 45 DAS.

The highest grain yield of 5.71 and 8.03 t/ha was recorded from two hand weeding during both the years of study. Similar results were also reported by Gill (2008) and Singh *et al*. (2009). Among the herbicides, pretilachlor + safener 0.45 kg/ha on 3 DAS followed by one hand weeding at 45 DAS produced the higher grain yield and it was at par with two hand weeding. Metamifop at 100 and 125 g/ha with one hand weeding at 45 DAS found to be the next best treatments. This might be attributed to better growth of plants on account of reduced crop - weed competition resulting in increased availability of nutrients, water and light. These results were in agreement with the findings of Chinnusamy *et al.* (2010) and Thomas *et al.* (2012). The lowest grain yield (2.09 and 2.37 t/ha) was recorded under unweeded control during both the years of investigation. Without controlling weeds, the loss in grain yield was 63.4% during 2011 and 70.5% during 2012.

It is clearly noted that pre emergence application of pretilachlor + safener 0.45 kg/ha followed by one hand

Table 3. Influence of weed management practices on growth, yield attributes and grain yield of rice

Treatment	Plant height at harvest (cm)		LAI at 90 DAS		Panicles/m^2		Grains/ panicle		Grain yield (t/ha)	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Metamifop 75 g/ha	89.9	98.8	4.10	5.80	252	270	117	117	3.12	3.54
Metamifop 100 g/ha	95.1	101.9	4.36	6.21	267	283	119	121	3.52	3.89
Metamifop 125 g/ha	97.5	103.2	4.89	6.09	283	298	120	122	3.65	4.01
Metamifop 200 g/ha	97.9	102.3	5.44	6.35	286	300	119	123	3.79	4.11
Pretilachlor + safener 450 g/ha	98.3	112.1	5.83	6.98	293	306	122	123	3.92	4.25
Cyhalofop-butyl 100 g/ha	92.6	103.3	4.42	6.04	265	279	118	119	3.34	3.77
Metamifop 75 g/ha + HW 45 DAS	107.1	123.9	6.19	7.03	326	344	125	130	4.77	6.72
Metamifop 100 g/ha + HW 45 DAS	110.3	125.4	6.97	7.54	340	374	127	132	5.18	7.46
Metamifop 125 g/ha + HW 45 DAS	111.0	125.6	7.19	8.05	351	386	128	133	5.21	7.75
Pretilachlor + safener 450 g/ha + HW 45 DAS	113.0	126.3	7.55	8.68	354	393	129	135	5.48	7.87
Hand weeding twice - 25 and 45 DAS	116.6	127.2	7.85	8.95	368	409	131	141	5.71	8.03
Unweeded control	84.1	93.4	3.08	4.85	149	182	108	110	2.09	2.37
LSD(P=0.05)	6.6	5.8	0.65	0.63	27	29	8	12	0.38	0.59

weeding at 45 DAS was resulted in significantly higher grain yield in DSR due to better control of weeds leading to lesser nutrient removal by weeds and higher uptake of nutrients by rice. Further, application of post-emergence herbicide metamifop 100 g/ha followed by one hand weeding at 45 DAS was found to be superior wherever the grassy weeds dominated. The results of two hand weeding were significantly better in terms of weed control and rice grain yield, but as it was time consuming and laborious, it cannot be recommended at large scale. Hence, pre-emergence application of pretilachlor + safener 0.45 kg/ha followed by one hand weeding at 45 DAS was found to be the best weed management practice in terms of weed control and higher yield in wet seeded rice cultivation.

REFERENCES

Balasubramanian V and Hill JE. 2002. Direct seeding of rice in Asia: Emerging issues and strategic research needs for 21st century. pp. 15-39. In: *Direct Seeding: Research Strategies and Opportunities*, (Eds. Pandey *et al*.). Proceedings of International Workshop on Direct Seeding in Asian Rice Systems: Strategic Research, Issues and Opportunities, 25-28 Jan., Bangkok, Thailand.

Singh B, Malik RK, Ashok Yadav and Nandal DP. 2009. Herbicide efficacy in seeded rice with different methods under wet and dry conditions. *Indian Journal of Weed Science* **41**(1&2): 37-40.

Chinnusamy C, Janaki P, Nithya C and Muthukrishnan P. 2010. Evaluation of grass herbicide – Metamifop on weed control and productivity of direct-seeded rice, pp. 282-283. In: *National Conference on Challenges in Weed Management in Agro-ecosystems - Present Status and Future Strategies,* Nov. 30 and Dec.1, TNAU, Coimbatore.

Gill MS. 2008. Productivity of direct seeded rice (*Oryza sativa*) under varying seed rates, weed control and irrigation levels. *Indian Journal of Agricultural Research* **78**(9): 766-770.

Gill GS and Vijaya Kumar. 1966. Weed index - A new method for reporting weed control trials. *Indian Journal of Agronomy* **14**(1): 96-98.

Mani VS, Mala ML, Gautam KC and Bhagavandas. 1973. Weed killing chemicals in potato cultivation. *Indian Farming* **23**(1): 17-18.

Prasad SM, Mishra SS and Singh SJ. 2001. Effect of establishment methods, fertility levels and weed management practices on rice (*Oryza sativa*). *Indian Journal of Agronomy* **46**(2): 216-221.

Sangeetha SP and Balakrishnan A. 2009. Yield and yield attributes of direct seeded rice as influenced by weed management practices under different seeding methods, p. 98. In: *National Symposium on Weed Threat to Environment, Biodiversity and Agriculture Productivity,* August 2-3, Tamil Nadu Agricultural University, Coimbatore, India**.**

Singh AP, Singh AK, Chaturvedi Sumit , Singh Shailender and Mishra OP. 2012. Bio-efficacy of sulfonylurea herbicides on mixed weed flora in transplanted rice. *Indian Journal of Agricultural Research* **46** (1): 9-15.

Singh AP, Choudhary Tapas , Kolhe SS, Gupta Shweta and Tomar GS. 2009. Effect of time of establishment and weed control methods on direct seeded rice in Chattisgarh, p. 93. In: *National Symposium on Weed Threat to Environment, Biodiversity and Agriculture Productivity,* August 2-3, Tamil Nadu Agricultural University, Coimbatore.

Sinha RKP, Singh AK and Singh BK. 2006. Zero and reduced tillage technologies boost up rice crop yield in Indo-Gangetic plains of Bihar, p. 502. *Abstract International Rice Congress* held at New Delhi, Oct.9-13.

Subramanian E, James Martin G and Balasubramanian R. 2006. Effect of integrated weed management practices on growth and yield of wet seeded rice (*Oryza sativa*) and their residual effect on succeeding pulse crop. *Indian Journal of Agronomy* **51**(2): 93-96.

Subramanian E, James Martin G, Rajakumar D and Durai Singh R. 2011. Weed and nitrogen management through inorganic and companion crops for drum seeded wet rice, *International Rice Research Notes* **36**: 57-60.

Thomas EK, Lalitha Bai, Ilangovan R and Johnkutty I. 2012. Weed management in dry direct seeded rice, p. 87. In: *Biennial Conference of Indian Society of Weed Science on Weed Threat to Agriculture, Biodiversity and Environment*, April 19-20, Kerala Agricultural University, Thrissur, Kerala.