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Weed management in direct wet seeded rice

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Abstract
Field experiment was conducted at Tamil Nadu Rice Research Institute, Aduthurai during *Kuruvai* season 2013 to evaluate the weed management practices in direct wet seeded rice. The weed management practices were : Pre-emergence (PE) pretilachlor + safener at 0.45 kg/ha on 3 DAS *fb* Early post-emergence (EPOE) metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS, PE pretilachlor + safener at 0.45 kg/ha on 3 DAS *fb* EPOE bispyribac-sodium at 25 g/ha on 25 DAS, PE pretilachlor + safener at 0.45 kg/ha *fb* cono weeder weeding on 25 DAS, PE pretilachlor + safener at 0.45 kg/ha *fb* drum type weeder weeding on 25 DAS compared with recommended practice of PE pretilachlor + safener at 0.45 kg ha^{-1} *fb* hand weeding on 40 DAS, hand weeding on 20 and 45 DAS and unweeded control. The results revealed that the lowest total weed density, total weed dry weight and higher weed control efficency, yield parameters and yield of rice were recorded in hand weeding on 20 and 45 DAS and it was followed by PE pretilachlor + safener at 0.45 kg/ha *fb* hand weeding on 40 DAS and PE pretilachlor + safener at 0.45 kg/ha *fb* EPOE metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS. However, the net returns and BC ratio were higher in PE pretilachlor + safener at 0.45 kg/ha *fb* EPOE metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS.

Keywords: direct wed seeded rice, weed management, weed control efficiency, yield, economics

Introduction
Rice (*Oryza sativa* L.) is the staple food in most of the Indian states and plays a major role in Indian economy by contributing 45 per cent of the total food grain production. In India, rice is grown in an area of 43.9 million hectares annually with a production of 109.7 million tonnes and an average productivity of 2.5 t/ha (FAO, 2016-17) [2].

In Tamil Nadu, rice is being cultivated under different ecosystems *viz.*, transplanted puddled lowland rice, direct seeded lowland rice (Wet seeded rice in puddled soil and Dry seeded rice in un-puddled soil), dry seeded upland rice and deep water rice. Most of the farmers in the intensive cropping areas are shifting from transplantation to direct seeding practices due to shortage of labour and scarcity of water. Additionally, late onset of monsoon, unpredictable rainfall pattern and delayed release of canal (Cauvery) water favour to go in for dry or wet seeding under puddled condition. Direct Seeded Rice (DSR) may involve sowing of pre-germinated seeds in a puddled soil surface (wet-seeding) or into shallow standing water (water-seeding), or dry seeds into a prepared seedbed (dry-seeding).

Weeds are the prime yield-limiting biotic constraints that compete with rice for moisture, nutrients and light. The yield loss due to weeds varies from 40 to 100 per cent in direct seeded rice (Jitendra Kumar *et al.*, 2010) [4]. In DSR under puddled condition, grasses cause maximum yield reduction followed by sedges and broad leaved weeds. Any delay in weeding will lead to increased weed biomass which has a negative correlation with yield. Though manual weeding is considered to be the best, undependable labour availability and escalating labour cost in many cases have given impetus to the development and use of new chemicals for weed control. Thus, nowadays chemical weed control in DSR has gained importance because of the intensity of weed problems coupled with the scarcity of labour for weeding and its escalated cost. Hence, this study was undertaken to evaluate integrated weed management practices for direct wet seeded rice.

Materials and Methods
Field experiment was conducted at Tamil Nadu Rice Research Institute, Aduthurai during *Kuruvai* season 2013. The experiment was laid out in randomized block design with eight treatments in three replications. The treatments comprised of weed management practices *viz.* Pre-emergence (PE) pretilachlor + safener at 0.45 kg/ha on 3 DAS *fb* Early post-emergence (EPOE) metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS, PE pretilachlor + safener at 0.45 kg/ha on 3 DAS *fb* EPOE bispyribac-sodium at 25 g/ha on 25 DAS, PE pretilachlor + safener at 0.45 kg/ha *fb* cono weeder weeding on 25 DAS, PE pretilachlor +

safener at 0.45 kg/ha *fb* drum type weeder weeding on 25 DAS compared with recommended practice of PE pretilachlor + safener at 0.45 kg ha^{-1} *fb* hand weeding on 40 DAS, hand weeding on 20 and 45 DAS and unweeded control. The variety used for the experiment was *'ADT 43'*.

Total weed density and weed dry weight was recorded at 20, 40 and 60 days after sowing (DAS) by adopting standard procedure. The weed control efficiency (WCE) was computed by using the formula as suggested by Mani *et al.* (1973) [7].

The yield parameters *viz.*, productive tillers/m^2, number of filled grains/panicle and 1000 grain weight and yield of rice were recorded at harvest stage. Economics of weed management was worked out by using the current market price of inputs and rice grain.

Results and Discussion

Effect on weeds

The common weed flora observed in the experimental field during the course of study consisted of grasses, sedges and broad leaved weeds (BLW). The major grass weeds were *Echinochloa crusgalli* (L.), *Echinochloa colona* (L.), *Leptochloa chinensis* (L.) and *Panicum repens* (L.) and the common sedges included *Cyperus difformis* (L.), *Cyperus iria* (L.) and *Fimbristylis miliacea* (L.). Among the BLW, *Eclipta alba* (L.), *Ammania baccifera* (L.) and *Ludwigia parviflora* Roxb. were the dominant species. Such broad spectrum of weeds in direct wet seeded rice ecosystem was also reported by Sindhu *et al*. (2010) [15] and Parthiban *et al.* (2013) [11].

Weed menace is greater in direct wet seeded rice as both grow simultaneously. Weed management practices had marked influence on total weed density, total weed dry weight and weed control efficiency at all the stages of observation (20, 40 and 60 DAS). Hand weeding on 20 and 45 DAS recorded lower weed density, weed dry weight and higher weed control efficency at 20 DAS when compared to application of PE herbicides and also their integration with HW on 40 DAS. This would be attributed to efficient and timely control of weeds accomplished through manual weeding twice at 20 and 45 DAS. The advantage of manual weeding was in agreement with the findings of Ramesh *et al*. (2009) [12] who reported that minimum weed density was observed in twice hand weeded plots.

At 40 DAS, PE pretilachlor + safener at 0.45 kg/ha *fb* hand weeding on 40 DAS recorded lower weed density, weed dry weight and higher weed control efficiency and it was followed by PE pretilachlor + safener at 0.45 kg/ha *fb* EPOE metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS. The results were in conformity with findings of Sanjay *et al*. (2006) [14] and Mishra and Singh (2007) [9].

At 60 DAS, hand weeding on 20 and 45 DAS recorded lower weed density, weed dry weight and higher weed control efficiency and it was followed by PE pretilachlor + safener at 0.45 kg/ha *fb* hand weeding on 40 DAS and PE pretilachlor + safener at 0.45 kg/ha *fb* EPOE metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS. This is in line with the findings of Chauhan and Albugo (2013) [1].

Effect of weed management practices on rice

Yield attributes and yield

Yield parameters *viz.*, productive tillers m^{-2} and no. of filled grains $panicle^{-1}$ were altered significantly by adoption of weed management practices. Hand weeding on 20 and 45 DAS recorded higher number of productive tillers m^{-2} (372) and no. of filled grains $panicle^{-1}$ (133) and it was on par with PE pretilachlor + safener at 0.45 kg/ha *fb* hand weeding on 40 DAS and PE pretilachlor + safener at 0.45 kg/ha *fb* EPOE metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS. The effective control of weeds in these treatments resulted in lesser competition by weeds for nutrients, space and light ultimately resulting in increased number of productive tiller m^{-2}. Pre emergence herbicide application controlled weeds at early stage and supplemental early post emergence herbicide controlled weed growth at later stage. Which resulted in higher weed control efficiency and yield attributes. This is in accordance with the findings of Sangeetha *et al.* (2009) [13].

Unweeded control resulted in reduced yield parameters due to severe crop weed competition coupled with reduced uptake of nutrients by crop and increased uptake of nutrients by weeds. 1000 grain weight was not significantly influenced by different weed management practices. This corroborates with the findings of Mandhata and Singh (2010) [6].

Adoption of different weed management practices significantly influenced the grain and straw yields. The highest grain and straw yields (4.91 t/ha and 7.45 t/ha) were recorded by hand weeding on 20 and 45 DAS. This was comparable with PE pretilachlor + safener at 0.45 kg/ha *fb* hand weeding on 40 DAS and PE pretilachlor + safener at 0.45 kg/ha *fb* EPOE metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS. This might be due to cumulative effect of increased levels of yield attributes was due to lesser crop weed competition, better light transmission for photosynthesis, reduced nutrient removal by weeds and increased nutrient uptake by crop. These results are in conformity with the findings of Ni *et al.* (2000) [10]. Severe crop weed competition in unweeded control plots due to uncontrolled growth of weeds resulted in the lowest grain and straw yields. This is in line with the findings of Parthiban *et al.* (2013) [11].

Economic analysis

Application of PE pretilachlor + safener at 0.45 kg/ha + EPOE metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS gave maximum net returns and BCR (Rs.42371/ha and 2.23). This was due to the higher grain and straw yield and lesser cost of cultivation. This results fall in line with findings of Ghosh (2010) [3]. and Kachroo and Bazaya (2011) [5]. Unweeded control gave the lowest net return and BCR (Rs.4030/ha and 1.13) due to drastic reduction in grain yield as a result of uncontrolled weed growth throughout the crop period. This is in conformity with the findings of Mirza Hasanuzzaman *et al.* (2009) [8].

From the study it could be concluded that the application of PE pretilachlor + safener at 0.45 kg/ha + EPOE metsulfuron methyl + chlorimuron ethyl at 4 g/ha on 25 DAS was found to be an ideal weed management options for controlling weeds, higher productivity and profitability of direct wet seeded rice.

Table 1: Effect of weed management practices on total weed density, total weed dry weight and weed control efficiency in direct wet seeded rice

Treatments	Total weed density (No./m^2)			Total weed dry weight (g/m^2)			Weed control efficiency (%)		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
PE pretilachlor + safener at 0.45 kg/ha *fb* EPOE metsulfuron methyl + chlorimuron ethyl at 4 g /ha on 25 DAS	7.50 (56.3)	4.87 (23.7)	5.71 (32.6)	4.05 (16.4)	4.30 (18.5)	5.89 (34.7)	77.1	84.5	83.3
PE pretilachlor + safener at 0.45 kg/ha *fb* EPOE bispyribac sodium at 25 g/ha on 25 DAS	7.33 (53.7)	5.18 (26.8)	5.89 (34.7)	3.85 (14.8)	4.62 (21.3)	6.09 (37.1)	79.3	82.2	82.1
PE pretilachlor + safener at 0.45 kg/ha *fb* cono weeder weeding on 25 DAS	7.56 (57.2)	6.80 (46.3)	8.41 (70.7)	4.02 (16.2)	7.27 (52.8)	9.20 (84.7)	77.4	55.9	59.2
PE pretilachlor + safener at 0.45 kg/ha *fb* drum type weeder weeding on 25 DAS	7.25 (52.5)	7.40 (54.8)	8.96 (80.3)	3.82 (14.6)	7.78 (60.6)	9.82 (96.5)	79.6	49.3	53.5
PE pretilachlor + safener at 0.45 kg/ha *fb* hand weeding on 40 DAS	7.36 (54.2)	4.64 (21.5)	5.12 (26.2)	3.95 (15.6)	4.09 (16.7)	5.69 (32.4)	78.2	86.0	84.4
Hand weeding on 20 and 45 DAS	3.97 (15.8)	6.73 (45.3)	4.73 (22.4)	3.03 (9.2)	5.40 (29.2)	5.13 (26.3)	87.2	75.6	87.3
Unweeded control	11.11 (123.4)	12.07 (145.8)	13.69 (187.3)	8.46 (71.6)	10.94 (119.6)	14.40 (207.5)	-	-	-
LSD (p=0.05)	0.72	0.40	0.62	0.39	0.56	0.75	-	-	-

Figures in parentheses are original values
DAS – Days after sowing

Table 2: Effect of weed management practices on the yield parameters, yield and economics of direct wet seeded rice

Treatments	Yield parameters			Yield		Economics	
	No. of productive tillers/m^2	No. of filled grains/ panicle	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net return (Rs ha^{-1})	BCR
PE pretilachlor + safener at 0.45 kg/ha *fb* EPOE metsulfuron methyl + chlorimuron ethyl at 4 g /ha on 25 DAS	356	125	17.3	4.77	6.98	42371	2.23
PE pretilachlor + safener at 0.45 kg/ha *fb* EPOE bispyribac sodium at 25 g/ha on 25 DAS	348	118	17.2	4.63	6.81	39110	2.11
PE pretilachlor + safener at 0.45 kg/ha *fb* cono weeder weeding on 25 DAS	306	108	17.0	4.29	6.22	34094	1.97
PE pretilachlor + safener at 0.45 kg/ha *fb* drum type weeder weeding on 25 DAS	276	103	17.0	4.08	5.62	30601	1.87
PE pretilachlor + safener at 0.45 kg/ha *fb* hand weeding on 40 DAS	365	127	17.3	4.85	7.02	41566	2.14
Hand weeding on 20 and 45 DAS	372	133	17.4	4.91	7.45	39603	2.01
Unweeded control	217	88	16.9	2.24	3.52	4030	1.13
LSD (p=0.05)	28	8.0	NS	0.32	0.59	-	-

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