



## Effect of Pre and Post Emergence Herbicides and Various Establishment Methods on Productivity and Profitability of Rice Under Sodic Soil Environment

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Field experiments were conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli during rabi 2011-12 and 2012-13 to study the effect of pre and post emergence herbicides and various establishment methods on productivity and profitability of rice under sodic soil environment. The soil was sandy clay loam with pH of 8.82 and 8.96 during rabi 2011-12 and 2012-13, respectively. Medium duration rice cultivar TRY 1 was used during both the years. Four crop establishment techniques viz., manual line transplanting, mechanical line transplanting, Direct Planting System (DPS) and drum seeded rice; and six weed management practices viz., PE pyrazosulfuron ethyl 30 g a.i. ha<sup>-1</sup> + POE almix 4 g a.i. ha<sup>-1</sup>, PE pyrazosulfuron ethyl 30 g a.i. ha<sup>-1</sup> + POE bispyribac sodium 20 g a.i. ha<sup>-1</sup>, PE londax power 10.0 kg ha<sup>-1</sup> + POE almix 4 g a.i. ha<sup>-1</sup>, PE londax power 10.0 kg ha<sup>-1</sup> + POE bispyribac sodium 20 g a.i. ha<sup>-1</sup>, two hand weeding and un-weeded control were main and sub plot treatments, respectively. The experiments were laid out in a strip plot design with three replications. The results showed that Direct Planting System (DPS) recorded higher weed control efficiency, productivity and profitability of rice; and among weed management practices, hand weeding twice at 20 and 40 DAT/S registered higher weed control efficiency and productivity of rice; and it was comparable with PE pyrazosulfuron ethyl 30 g a.i. ha<sup>-1</sup> + POE bispyribac sodium 20 g a.i. ha<sup>-1</sup> during both the years of study. In economic point of view, PE pyrazosulfuron ethyl 30 g a.i. ha<sup>-1</sup> + POE bispyribac sodium 20 g a.i. ha<sup>-1</sup> recorded higher net income, and B:C ratio during both the years.

**Key words:** Crop establishment methods rice, weed management practices, weed control efficiency, yield

Rice is the most important crop in India, which plays a critical role in food security. It suffers from various biotic and abiotic production stresses. Severe competition from weeds is one of the important biotic factors deterring productivity and sustainability. Weeds can cause a reduction of 28-45 % of grain yield in transplanted rice (Singh *et al.*, 2003). Many weed control methods are practiced for better control of weeds in rice crop. Herbicides look better option than other methods because of their performance in controlling weeds and decreasing weed competition with crop. In recent years, chemical weed management is considered as an effective weed control method by using low dose high efficiency herbicides. Some promising low dose high efficacy pre- and post-emergence herbicides are available for control of wide spectrum of weed flora in lowland rice (Moorthy, 2002). In the present study, the work was carried out to study the effect of crop establishment methods and weed management practices on weed control efficiency, yield and economics of rice under sodic soil environment.

### Materials and Methods

Field experiments were conducted during rabi 2011-12 and 2012-13 at Anbil Dharmalingam

Agricultural College and Research Institute, Tiruchirappalli. The soil was sandy clay loam with pH of 8.82 and 8.96 and electrical conductivity of 0.82 and 0.93 dS m<sup>-2</sup> during rabi 2011-12 and 2012-13, respectively. The nutrient status of the soil was low in available nitrogen, medium in available phosphorus and potassium. Medium duration rice cultivar TRY 1 was used during both the years. The field experiments were laid out in strip plot design with three replications. Four crop establishment methods viz., manual line transplanting, mechanical line transplanting, Direct Planting System (DPS) and drum seeded rice; and six weed management practices viz., pre-emergence pyrazosulfuron ethyl 30 g a.i. ha<sup>-1</sup> at 3 DAT / 8 DAS + post-emergence almix 4 g a.i. ha<sup>-1</sup> at 21-25 DAT / 20 DAS, pre-emergence pyrazosulfuron ethyl 30 g a.i. ha<sup>-1</sup> at 3 DAT / 8 DAS + post-emergence bispyribac sodium 20 g a.i. ha<sup>-1</sup> at 15- 20 DAT / 20 DAS, pre-emergence londax power 10.0 kg ha<sup>-1</sup> at 0-3 DAT / 10-15 DAS + post-emergence almix 4 g a.i. ha<sup>-1</sup> at 21-25 DAT / 20 DAS, pre-emergence londax power 10.0 kg ha<sup>-1</sup> at 0-3 DAT / 10-15 DAS + post-emergence bispyribac sodium 20 g a.i. ha<sup>-1</sup> at 15-20 DAT / 20 DAS, two hand weeding at 20 and 40 DAT/S and un-weeded control were taken for the experiments. Fertilizers were applied at the rate of 150: 50: 50 kg of N, P and K ha<sup>-1</sup>, respectively.

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Weed species present in the experimental plot were identified at flowering stage of crop from un-weeded control plot and grouped as grasses, sedges and broad leaved weeds (BLW). Weed control efficiency was worked out from weed dry weight during both the years.

## Results and Discussion

General weed flora observed in rice fields in ADAC & RI, Tiruchirappalli are listed in Table 1. Major

**Table 1. Weed flora of rice fields in ADAC & RI, Tiruchirappalli.**

Botanical name	Common name	Life form	Family
<b>Grasses</b>			
<i>Echinochloa crus-galli</i>	Barnyard grass	A	Poaceae
<i>Echinochloa colonum</i> *	Jungle Rice Varsanampul (Tamil)	A	Poaceae
<i>Panicum repens</i> *	Grass	A	Poaceae
<i>Dinebera retroflexa</i>	Grass	A	Poaceae
<b>Sedges</b>			
<i>Cyperus rotundus</i> *	Purple nut sedge Koraikizhangu (Tamil)	P	Cyperaceae
<i>Cyperus difformis</i>	Umbrella plant Vatta Korai (Tamil)	A	Cyperaceae
<i>Fimbristylis miliacea</i>	Hoorah grass	A	Cyperaceae
<b>Broad leaved weeds</b>			
<i>Ammannia baccifera</i> *	Red stem	A	Lythraceae
<i>Eclipta alba</i> *	False daisy	A	Asteraceae
<i>Marsilea quadrifoliata</i>	The Water Fern Arai Keerai (Tamil)	P	Marsileaceae
<i>Bergia capensis</i> *	Nandu kaal keerai (Tamil)	A	Elatinaceae
<i>Monochooria vaginalis</i>	Neer thamarai (Tamil)	A	Pontederiaceae

\* Weeds present in experimental fields  
A - Annual; P - Perennial

weeds found in rice fields were *Echinochloa colonum* (L.), *Echinochloa crus-galli* (L.) among grasses; *Cyperus rotundus*, *Cyperus difformis* among sedges and *Ammannia baccifera*, *Eclipta alba*, *Marsilea quadrifoliata*, *Bergia capensis* among broad leaved weeds. Weed flora of the experimental rice fields was observed in un-weeded control which is presented in Table 1. In general, weed density was higher during rabi 2012-13 than rabi 2011-12. Predominant weeds infesting the rice fields were *Echinochloa colonum* (L.) among grasses; *Cyperus rotundus* (L.) among sedges and *Eclipta alba* (L.) among broad leaved weeds.

### Effect of treatments on Weed control efficiency

Among crop establishment methods, DPS recorded higher weed control efficiency of 76.67 and 78.23 per cent at 45 DAS during rabi 2011-12 and 2012-13, respectively (Table 2). This results showed that in DPS, besides weeding treatment, rotary weeder was used to thin the plant stand twice at early stages of crop growth, which greatly reduced the weed density as well as weed dry weight. Higher weed density and dry weight in drum seeded rice with lower weed control efficiency during both the years might be due to the reason that in direct seeded rice, distinguishing grassy weeds and rice seedlings was difficult as weeds and crops grew simultaneously (Reddy *et al.*, 1994).

**Table 2. Effect of crop establishment methods and weed management practices on weed control efficiency (per cent) in rice at 45 DAT/S during rabi 2011-12 and 2012-13**

Treatment	Rabi 2011-12	Rabi 2012-13
<b>Establishment methods</b>		
<b>M<sub>1</sub></b> - Manual line transplanting	73.81	74.36
<b>M<sub>2</sub></b> - Mechanical line transplanting	76.03	74.68
<b>M<sub>3</sub></b> - Direct Planting System (DPS)	76.67	78.23
<b>M<sub>4</sub></b> - Drum seeded rice (Sprouted seeds)	72.32	74.38
<b>Weed management practices</b>		
<b>S<sub>1</sub></b> - PE Pyrazosulfuron Ethyl 30 g a.i. ha <sup>-1</sup> at 3 DAT / 8 DAS + POE Almix 4 g a.i. ha <sup>-1</sup> at 21-25 DAT / 20 DAS	72.62	73.52
<b>S<sub>2</sub></b> - PE Pyrazosulfuron Ethyl 30 g a.i. ha <sup>-1</sup> at 3 DAT / 8 DAS + POE Bispyribac Sodium 20 g a.i. ha <sup>-1</sup> at 15- 20 DAT / 20 DAS	75.51	78.48
<b>S<sub>3</sub></b> - PE Londax power 10.0 Kg ha <sup>-1</sup> at 0-3 DAT / 10-15 DAS + POE Almix 4 g a.i. ha <sup>-1</sup> at 21-25 DAT / 20 DAS	70.83	68.52
<b>S<sub>4</sub></b> - PE Londax power 10.0 Kg ha <sup>-1</sup> at 0-3 DAT / 10-15 DAS + POE Bispyribac sodium 20 g a.i. ha <sup>-1</sup> at 15-20 DAT / 20 DAS	73.17	75.64
<b>S<sub>5</sub></b> - Two hand weeding at 20 and 40 DAT/S	81.40	80.91
<b>S<sub>6</sub></b> - Un-Weeded control	-	-

(Data statistically not analysed)

With regard to weed management practices, higher weed control efficiency was recorded (81.40 and 80.91 per cent at 45 DAT/S during rabi 2011-12 and 2012-13, respectively) in hand weeding twice at 20 and 40 DAT/S (Table 2). This was mainly because of the reason that manual weeding was more efficient to identify and destroy all group of weeds at later stages of crop. Bhanu Rekha *et al.* (2002) also stated that hand weeding twice at 20 and 40 DAT recorded higher weed control efficiency which resulted in significantly lower weed density and dry weight as compared to herbicide treatment and un-weeded check. This was followed by PE pyrazosulfuron ethyl 30 g a.i. ha<sup>-1</sup> at 3 DAT / 8 DAS + POE bispyribac sodium 20 g a.i. ha<sup>-1</sup> at 15- 20 DAT / 20 DAS due to the reason that this herbicide combination effectively controlled weeds at early and later stages of crop; accordingly, it recorded reduced weed dry weight during both the years of study. Effective control of sedge weeds and broad leaved weeds by PE has also been reported by Maiti *et al.*, (2003).

### Effect of treatments on productivity of rice

Among crop establishment methods, DPS recorded significantly higher grain yield of 5048 and 4639 kg ha<sup>-1</sup> during rabi 2011-12 and 2012-13, respectively (Table 3). This might be due to the reason that in DPS, single seedling was maintained like in the system of rice intensification due to rotary thinning at early stages; wider spacing (25 × 25 cm), better soil aeration due to rotary thinning and incorporation of weeds as well as extra seedling in to soil which served as additional nutrient to crop. Lower grain yield was obtained with drum seeded rice (3756 and 3466 kg ha<sup>-1</sup> during rabi 2011-12 and 2012-13, respectively) mainly because of higher weed infestation which lead to severe crop weed competition at early stages of crop resulting in reduced yield.

**Table 3. Effect of crop establishment methods and weed management practices on grain yield (kg ha<sup>-1</sup>) of rice during *rabi* 2011-12 and 2012-13**

Treat ment	Rabi 2011-12					Rabi 2012-13				
	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	M <sub>4</sub>	Mean	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	M <sub>4</sub>	Mean
S <sub>1</sub>	4157	4479	4926	3765	4332	4084	4240	4471	3398	4048
S <sub>2</sub>	4935	5061	5424	4295	4929	4634	4705	5107	4101	4637
S <sub>3</sub>	4078	4393	4715	3334	4130	3906	3987	4300	3167	3840
S <sub>4</sub>	4728	4776	5284	3817	4651	4350	4550	4786	3579	4316
S <sub>5</sub>	5268	5471	5759	4843	5335	5060	5194	5486	4508	5062
S <sub>6</sub>	3345	3986	4179	2480	3497	3018	3230	3685	2040	2993
Mean	4418	4694	5048	3756		4176	4318	4639	3466	
	M	S	M at S	S at M		M	S	M at S	S at M	
S.Ed.	101	176	176	223		85	162	132	188	
C.D. (P=0.05)	246	392	399	497		207	360	300	420	

Regarding weed management practices, hand weeding twice at 20 and 40 DAT/S recorded significantly higher grain yield (Table 3). Manual weeding gave better weed control which led to higher rice yield. Subha Lakshmi and Venkata Ramana (2008) reported that hand weeding at 20 and 40 DAT recorded higher plant height, dry matter production, tillers m<sup>-2</sup>, nutrient uptake by crop and lower nutrient uptake by weeds throughout the crop growth period and registered higher grain and straw yields. This was followed by PE Pyrazosulfuron Ethyl 30 g a.i. ha<sup>-1</sup> at 3 DAT/8 DAS + POE Bispyribac Sodium 20 g a.i. ha<sup>-1</sup> at 15- 20 DAT/20 DAS which registered higher grain yield during both the years. Sequential application of pre and post emergence herbicides had better weed control, reducing crop weed competition and increasing the crop yield. Timely and effective control of weeds with integrated use of pre and post emergence herbicides resulted in increased yield components, which ultimately reflected on grain yield (Deepthi Kiran and Subramanyam, 2010).

#### Effect of treatments on profitability of rice

Four rice establishment methods and six weed management practices critically influenced the economics of rice cultivation during both the years (Table 4). Higher net income and B:C ratio were arrived (Rs.20135, 32450 ha<sup>-1</sup> and 1.72, 2.16 of net income and B:C ratio during *rabi* 2011-12 and 2012-13, respectively) in DPS in both the years, which might be due to the reason that higher productivity, higher gross income (Rs.48112 and 60426 ha<sup>-1</sup> during *rabi* 2011-12 and 2012-13, respectively) and less cost of cultivation. Similar finding have been reported by Kalaiyarasi (2009), who has concluded that increased grain yield in DPS resulted in higher net return and benefit cost ratio.

Among weed management practices, hand weeding twice at 20 and 40 DAT/S recorded higher grain yield and also higher gross income (Rs. 50714 and 65335 ha<sup>-1</sup> during *rabi* 2011-12 and 2012-13, respectively). However, net return and B:C ratio were reduced mainly because of higher cost of cultivation in hand weeded treatment. Hasanuzzaman *et al.*

**Table 4. Effect of crop establishment methods and weed management practices on gross return, net return and BCR of rice during *rabi* 2011-12 and 2012-13**

Treatment	Gross return (Rs. ha <sup>-1</sup> )		Net return (Rs. ha <sup>-1</sup> )		B:C ratio	
	Rabi	Rabi	Rabi	Rabi	Rabi	Rabi
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
M <sub>1</sub>	42213	54415	12462	24664	1.42	1.82
M <sub>2</sub>	45012	56432	8212	19633	1.22	1.53
M <sub>3</sub>	48112	60426	20135	32450	1.72	2.16
M <sub>4</sub>	36400	45624	10076	19301	1.38	1.73
S <sub>1</sub>	41608	52958	13194	24544	1.49	1.89
S <sub>2</sub>	47132	60304	17384	30556	1.61	2.06
S <sub>3</sub>	39672	50191	10063	20582	1.35	1.71
S <sub>4</sub>	44658	56404	13715	25460	1.46	1.84
S <sub>5</sub>	50714	65335	14816	29437	1.43	1.84
S <sub>6</sub>	33820	40155	7156	13491	1.28	1.52

(Data statistically not analysed)

(2009) reported that maximum cost of weed control was required for hand weeding due to maximum labour requirement. Higher net income of Rs.17384 and 30555 ha<sup>-1</sup>; and higher B:C ratio of 1.61 and 2.06 during *rabi* 2011-12 and 2012-13, respectively was obtained in PE Pyrazosulfuron Ethyl 30 g a.i. ha<sup>-1</sup> at 3 DAT / 8 DAS + POE Bispyribac Sodium 20 g a.i. ha<sup>-1</sup> at 15- 20 DAT / 20 DAS. This might be mainly due to the reason that except in un-weeded control, lower cultivation cost was incurred and higher rice yield was obtained during both the years. Herbicidal weed control methods offer an advantage to save labour and money. Hence, it is regarded as the most cost effective method of weed control. In the amalgamation of treatment effect, PE Pyrazosulfuron Ethyl 30 g a.i. ha<sup>-1</sup> at 3 DAT / 8 DAS + POE Bispyribac Sodium 20 g a.i. ha<sup>-1</sup> at 15- 20 DAT / 20 DAS in the combination with all the rice establishment methods recorded higher B:C ratio during both the years of study.

#### Conclusion

It is concluded that direct planting system recorded higher weed control efficiency, productivity, higher net return and B:C ratio of rice during both the years of study. Among weed management practice, hand weeding recorded higher weed control efficiency and grain yield followed by PE Pyrazosulfuron Ethyl 30 g a.i. ha<sup>-1</sup> at 3 DAT / 8 DAS + POE Bispyribac Sodium 20 g a.i. ha<sup>-1</sup> at 15- 20 DAT / 20 DAS. Net income and B:C ratio were higher under PE Pyrazosulfuron Ethyl 30 g a.i. ha<sup>-1</sup> at 3 DAT / 8 DAS + POE Bispyribac Sodium 20 g a.i. ha<sup>-1</sup> at 15-20 DAT / 20 DAS. Although much effective, hand weeding is time consuming, expensive and tedious in the context of unavailability of labourers and increased wages. Hence, chemical weed management has emerged as an effective, timely and cost-effective weed control method without affecting the productivity of rice.

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