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Influence of Herbicidal Weed Management on Yield Attributes, Yield and Economics in Transplanted Rice *(Oryza sativa L.)*

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A field experiment was conducted from September 2011 to January 2012 at Tamil Nadu Agricultural University, Coimbatore to study the influence of pre and post plant herbicidal weed management on yield attributes, yield and economics in transplanted rice. The experiment was laid out in a Factorial randomised block design with three replications and two factors *viz.* **pre-plant herbicide application (with and without glyphosate at 0.75 kg a.i ha^{-1}) and pre emergence / early post emergence herbicide treatments consisting pre-emergence butachlor 1.25 kg a.i ha^{-1}, pretilachlor 0.75 kg a.i ha^{-1}, almix 20 g ha^{-1} on 3 days after transplanting followed by hand weeding at 40 DAT, early post emergence Bensulfuron methyl + pretilachlor (6.6 GR) @ 0.06+0.60 kg a.i ha^{-1} at 10 DAT, hand weeding twice at 20 and 40 DAT and unweeded control. The results revealed that pre-plant application of glyphosate resulted in higher number of productive tillers m^{-2} (440), more grains panicle^{-1} (121), increased panicle length (23.99 cm), increased panicle weight (2.60 g) and higher yield (5766 kg) and net returns (Rs 25,188 ha^{-1}) compared to non glyphosate application. Among the post plant weed management methods, number of productive tillers m^{-2}, grains panicle^{-1}, panicle weight, grain yield and net returns were higher in EPOE application of Bensulfuron methyl + pretilachlor (6.6 GR) @ 0.06 + 0.60 kg a.i ha^{-1} at 10 DAT (498m^{-2}, 11g, 24.56 cm, 2.71 g, 6100 kg ha^{-1} and Rs 33,120 ha^{-1}, respectively), followed by pretilachlor at 0.75 kg a.i ha^{-1} + HW at 40 DAT and HW twice at 20 and 40 DAT, which were comparable .**

Key words: Rice, pre-plant glyphosate, bensulfuron methyl + pretilachlor, yield attributes, grain yield, economics.

Rice is the global staple food of almost 3 billion people. More than 90 per cent of the world's rice produced is consumed in Asia, providing 50 per cent of the total calorie intake of Asia's population. India is the leading rice producing country in terms of area and it is the second largest producer next to china. Weeds compete with crops for water, light, nutrients and space. Weeds are the most competitive in their early growth stages than at later stages and hence the growth is affected and finally grain yield decreases (Jacob and Syriac, 2005). Generally, most herbicides are effective options for selective weed control and a single herbicide cannot control all weeds of the community (Corbelt *et al*., 2004). Although glyphosate has activity on a wide range of annual and perennial weeds, some weeds are more difficult to control with glyphosate than others (Jordan *et al.,* 1997; Yonce and Skroch, 1989). Application of some of the pre emergence herbicides including pedimethalin, butachlor, thiobencarb, oxadiazon, oxyfluorfen and nitrofen was found to provide a fair degree of weed control in transplanted rice (Pellerin and Webster, 2004). Transplanted rice yield during *rabi* season is affected severely due to weed infestation. Though the effect of pre emergence herbicides in transplanted rice has been studied in detail, there are very few studies on the combined effect of pre plant application along with pre emergence /post emergence herbicides in transplanted rice.

Hence, the present investigation was taken to study the pre and post plant herbicidal weed management in rice and its influence on yield attributes, yield and economics in transplanted rice.

Materials and Methods

The experiment was carried out during *rabi* 2011 in wetland farm, Tamil Nadu Agricultural University, Coimbatore, situated at 11 ^{0} N latitude, 77 ^{0} E longitude and at an altitude of 426.7 m above mean sea level to study the effect of pre and post plant herbicidal weed management in transplanted rice. The soil of the experimental field was clay loam in texture with pH of 8.58 and EC of 0.29 dS/m. The nutrient status of the soil was medium organic carbon (0.58%), low in available nitrogen (234 kg ha^{-1}), medium in available phosphorus (15.8 kg ha^{-1}) and high in available potassium (467 kg ha^{-1}). The test variety used in this experiment was CO(R) 50. The experiment was laid out in a factorial randomized block design with three replications and two factors.

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FACTOR A: ***Pre-plant application of herbicide***

A_1- Application of glyphosate 0.75 kg a.i ha^{-1} A_2 -Without application of glyphosate

FACTOR B*: Pre- emergence application of herbicides*

T_1 -PE Butachlor 1.25 kg ha^{-1} + Hand weeding at 40 DAT

T_2- EPOE Bensulfuron methyl+Pretilachlor (6.6 GR) @0.06+0.60 kg a.i ha^{-1}

T_3 -PE Pretilachlor @ 0.75 kg a.i ha^{-1} + Hand Weeding at 40 DAT

T_4- PE Almix 20 g ha^{-1} + Hand Weeding at 40 DAT

T_5- Hand weeding twice (20 & 40 DAT)

T_6- Unweeded check

Prior to land preparation, the field was divided into two equal plots by forming bund between them. The first plot was sprayed with pre-plant herbicide glyphosate (Factor A_1) and the second plot without herbicide glyphosate (Factor A_2). The spacing between two plots was kept 1m and all the field operation likes puddling and levelling was carried out separately. The seeds of rice cv. CO(R) 50 were sown. Pre emergence herbicides were applied using fan type nozzle at 3 days after transplanting while the Bensulfuron methyl + pretilachlor (6.6 GR) was applied as early post-emergence herbicide on 10 DAT. The herbicides were applied keeping a thin film of water in the field. The field was neither drained nor irrigated for 2 days after application of herbicides. Yield components like number of panicle m^{-2}, grains $panicle^{-1}$, panicle length and panicle weight were recorded as per the guidelines stipulated by the All India Co-ordinated Rice Improvement Project (Haveten, 1977).

Results and Discussion

Weed flora

The dominant weeds of the experimental field consisted of grasses, sedges and broad leaved weeds. Observations on weed species were made prior to pre-plant glyphosate application stage and at flowering stage of the rice crop. The major grass weeds were *Echinochloa crus-galli* (L.), *Echinochloa colonum* (L.) and the major sedge weed was *Cyperus iria* (L.). Among the broad leaved weeds *Ammania baccifera* (L.) and *Marseilea quadrifolia* were the dominant species. Grasses were predominant and constituted 43.6 per cent of the weed flora. This was followed by sedges which accounted for 39.7 per cent. The broad leaved weeds occupied third position in terms of intensity.

Effect on yield attributes

Panicle length, panicle weight and grains $panicle^{-1}$ were higher under pre-plant glyphosate 0.75 kg a.i. ha^{-1}(29.99 cm, 2.60 g and 121, respectively), compared to non glyphosate application (23.14 cm, 2.42 g and 109, respectively), because pre-plant glyphosate application eliminated most existing vegetation and prevented weed establishment, resulting in less weed competition. This led to increased availability of resources to the rice crop, resulting in the better yield parameters recorded in the present study. Among weed control methods, panicle length, panicle weight and grain $panicle^{-1}$ were higher in EPOE Bensulfuron methyl + pretilachlor (6.6 GR) @0.06+0.60 kg ha^{-1}. This was followed by pretilachlor 0.75 kg a.i. ha^{-1} + HW at 40 DAT (24.56 cm, 2.71

Table 1. Effect of weed management practices on yield attributes of rice

	Productive tillers m^{-2}			Panicle length (cm)			Panicle Weight (g)			Filled grain $panicle^{-1}$ m^{-2}			1000 grain weight (g)		
Treatment	A_1	A_2	Mean	A_1	A_2	Mean	A_1	A_2	Mean	A_1	A_2	Mean	A_1	A_2	Mean
T_1-PE Butachlor 1.25 kg ha^{-1} + Hand weeding at 40 DAT	469	472	470	24.40	23.95	24.18	2.62	2.59	2.60	121	110	115	17.71	17.00	17.35
T_2-EPOE Bensulfuron methyl + pretilachlor (6.6 GR) @0.06+0.60 kg ha^{-1} at 10 DAT	518	499	508	25.40	24.43	24.91	3.01	2.74	2.88	129	116	122	18.98	17.85	18.41
T_3-PEPretilachlor @ 0.75 kg ha^{-1} + Hand Weeding at 40 DAT	504	493	499	24.80	24.36	24.56	2.89	2.67	2.71	123	114	118	17.87	17.63	17.75
T_4-PE Almix 20 g ha^{-1} + Hand Weeding at 40 DAT	478	456	468	24.36	22.80	23.58	2.49	2.41	2.45	119	108	114	17.49	17.27	17.38
T_5-Hand weeding twice (20 & 40 DAT)	484	484	485	24.9	23.53	24.21	2.73	2.45	2.59	126	115	120	18.03	17.72	17.87
T_6-Unweeded check	189	171	180	20.0	19.66	20.23	1.90	1.64	1.77	107	91	99	16.84	16.30	16.57
Mean	441	429		23.99	23.14		2.60	2.42		121	109		17.82	17.29	
	A	T	A*T	A	T	A*T	A	T	A*T	A	T	A*T	A	T	A*T
SEd	3	7	8	0.18	0.32	0.46	0.02	0.04	0.06	1	2	2	0.06	0.12	0.17
CD (p=0.05)	7	12	NS	0.39	0.68	NS	0.05	0.09	NS	2	4	NS	NS	NS	NS

A1: Glyphosate 0.75 kg a.i ha-1 A2: Without glyphosate PE: Pre emergence 3 DAT EPOE: Early post emergence 10 DAT

g and 118, respectively) (Table 1). Uniform crop stand coupled with better and prolonged control of weeds, resulted in better crop growth and productive tillers m^{-2}. These treatments recorded higher filled grain panicle^{-1}, which could be due to the increase of sink. These results are in agreement with the findings of Gnanavel and Anbhazhagan (2010). Pre-plant application of glyphosate 0.75 kg a.i. ha^{-1} (A_1) recorded higher number of productive tillers (440 m^{-2}) compared to non application of glyphosate (429 m^{-2}). Among the weed control methods, EPOE Bensulfuron methyl + pretilachlor (6.6 GR) @ 0.06+0.60 kg a.i. ha^{-1} (T_2) recorded the highest numbers of productive tillers (508 m^{-2}), followed by pretilachlor 0.75 kg a.i ha^{-1} + HW on 40 DAT (498 m^{-2}). Unweeded check recorded the lowest yield attributes. This was due to severe competition exerted by weeds for space, light, nutrients throughout the crop growth period as reported by Choudhary and Thakuria (1998).

Effect on grain yield

Higher grain yield was recorded with pre-plant glyphosate 0.75 kg a.i. ha^{-1}(5766 kg ha^{-1}) compared to non glyphosate application (5116 kg ha^{-1}), because of better weed control and favourable environment for better crop growth and yield. Among weed control methods, higher grain yield was recorded in EPOE Bensulfuron methyl + pretilachlor (6.6 GR) @ 0.06+0.60 kg ha^{-1} (6450 kg ha^{-1}), followed by pretilachlor 0.75 kg ha^{-1} + HW at 40 DAT(6100 kg ha^{-1}) (Table 2) because of less weed competition which led to better crop growth and yield parameters, ultimately resulting in increased crop yield. Unweeded check recorded the lowest yield of 3700 kg ha^{-1}. Similar finding was reported by Saha and Rao (2010). The next best treatment was butachlor 1.25 kg a.i. ha^{-1}+ HW 40 DAT (5900 kg ha^{-1}) followed by HW 20 and 40 DAT (5750 kg ha^{-1}). The favourable conditions created through the efficient weed control resulted in lesser weed competition between the crops and weeds. This favoured the crop to produce more LAI and plant dry matter production, increased productive tillers and yield over unweeded check.

Economics

Pre-plant application of glyphosate 0.75 kg a.i ha^{-1} recorded the highest net return (Rs 25,188) compared to non glyphosate application (Rs 22,579).

Table 2. Effect of weed management practices on grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and economics of rice

	Grains yield			Straw yield			Net Return Rs ha^{-1}			B:C ratio		
Treatment	A_1	A_2	Mean	A_1	A_2	Mean	A_1	A_2	Mean	A_1	A_2	Mean
T_1-PE Butachlor 1.25 kg ha^{-1} + HW on 40 DAT	6200	5600	5900	8530	8017	8273	28553	25575	27064	2.02	1.92	1.97
T_2-EPOE Bensulfuron methyl + Pretilachlor (6.6 GR)0.06+0.60 kg ha^{-1} on 10 DAT	6800	6100	6450	8667	8561	8614	35043	31197	33120	2.30	2.08	2.19
T_3-PE Pretilachlor @ 0.75 kg ha^{-1} HW on 40 DAT	6400	5800	6100	8633	8360	8496	32159	27950	30054	2.13	2.09	2.11
T_4-PEAlmix 20 g ha^{-1}+ HW on 40 DAT	5100	4400	4750	7976	7417	7696	28317	24487	26402	1.98	1.94	1.96
T_5-Hand weeding twice 20 and 40 DAT	6100	5400	5750	8200	8000	8100	27057	26265	26661	1.90	1.88	1.89
T_6-Unweeded check	4000	3400	3700	7000	6700	6850	2597	2495	2546	1.10	1.09	1.09
Mean	5766	5116		8167	7842		25188	22579		1.90	1.83	
	A	T	A*T	A	T	A*T				2.02	1.92	1.97
SEd	131	227	321	96	166	235				2.30	2.08	2.19
CD (P=0.05)	272	471	NS	199	345	NS				2.13	2.09	2.11

A_1 : Glyphosate 0.75 kg a.i ha^{-1} A_2 : Without glyphosate spray PE: Pre emergence 3 DAT EPOE: Early post emergence 10 DAT

Herbicide application EPOE Bensulfuron methyl + pretilachlor (6.6 GR) at 10 DAT (T_2) registered higher gross returns (Rs. 59,318 ha^{-1}), net return (Rs. 33, 120 ha^{-1}) and B: C ratio (2.19). This was followed by pretilachlor at 0.75 kg a.i. ha^{-1} + HW at 40 DAT with a gross return of Rs. 57569 ha^{-1}, net return of Rs. 30, 054 ha^{-1} and B: C ratio of 2.11. This might be due to increased grain and straw yield recorded in these treatments, due to better control of weeds which led to less competition for resources leading to better crop performance. The unweeded check recorded lower gross return of Rs. 27, 967 ha^{-1}; net return of Rs. 2,546 ha^{-1} and B: C ratio of 1.09 due to uncontrolled weeds. This result is in line with the findings of Raju and Reddy (1995) and Hasanuzzaman *et al.* (2009).

Among the herbicides and weed control methods tried, EPOE Bensulfuron methyl + pretilachlor (6.6 GR) @ 0.06+0.60 kg a.i ha^{-1} at 10 DAT recorded better yield attributes as well as increased yield and economics in rice.

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