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Evaluation of Different Weed Management Practices on Yield attributes and Yield of Transplanted Rice

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A B S T R A C T

A field experiment was carried out at Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Trichy during *Rabi*, 2018 to study the effect of different weed management practices on yield attributes and yield of transplanted rice. The experiment was laid out in split plot design with four main plot and five sub plot treatments and replicated thrice. The experimental plot size was 20 m^2. Main plot treatments were pre plant application of herbicides namely, glyphosate 2.5 kg ha^{-1}, glufosinate ammonium 1.0 kg ha^{-1},halosulfuron methyl 67.5 g ha^{-1} and control. Sub plot treatments consisted of different weed management practices in transplanted rice namely, pre emergence application of bensulfuron methyl + pretilachlor 660 g ha^{-1} on 3 DAT + one hand weeding on 45 DAT, post emergence application of bispyribac sodium 25 g ha^{-1} on 15 DAT + one hand weeding on 45 DAT, application of bensulfuron methyl + pretilachlor 660 g ha^{-1} on 3 DAT + bispyribac sodium 25 g ha^{-1} on 25 DAT, hand weeding twice at 25 and 45 DAT and unweeded control. Pre plant herbicides sprayed 15 days before puddling. The rice variety TRY 3 was grown during the course of investigation. Pre plant application of glyphosate 2.5 kg ha^{-1} recorded significantly higher yield attributes and yield viz., productive tillers (350 m^{-2}), Panicle length (24.4 cm), filled grains (153 $panicle^{-1}$), total grains (171 $panicle^{-1}$), higher grain yield (4232 kg ha^{-1}), straw yield (6986 kg ha^{-1}) and harvest index (0.38 %) than halosulfuron methyl and control. These results are closely followed by glufosinate ammonium 1.0 kg ha^{-1}. Among the weed management practices fallowed in transplanted rice, post emergence application of bispyribac sodium 25 g ha^{-1} + hand weeding on 45 DAT registered significantly higher yield attributes and yield Viz., productive tillers (338 m^{-2}), Panicle length (24.7 cm), filled grains (159 $panicle^{-1}$), total grains (179 $panicle^{-1}$), higher grain yield (4327 kg ha^{-1}) and harvest index (0.39 %) than others. Pre emergence application of bensulfuron methyl + pretilachlor 660 g ha^{-1} + post emergence application of bispyribac sodium 25 g ha^{-1} on 25 DAT significantly registered higher straw yield of 7174 kg ha^{-1}over unweeded control.

Introduction

Rice (*Oryza sativa* L.) is the staple food for more than 60 per cent of the world population and its cultivation secures a livelihood for more than two billion people. In India, rice is grown in an area of 43.79 million hectare with a production of 112.91 million tonnes and an average productivity of 2.5 tonnes hectare^{-1} (Anonymous, 2018). In Tamil Nadu, rice is grown in an area of 1.85 million hectares with a production of 6.95 million tonnes and an average productivity of 3.7 tonnes hectare^{-1} (Anonymous, 2019).

Weeds are the major biotic constraint to reduce the rice productivity in worldwide. In transplanted rice, about 60 % of the weeds emerge in the period of one week to one month after transplanting. These emerging weeds are competing with rice during effective tillering stage and decline the quantity of panicles leads to reduction in grain yield (Soe thura, 2010). In transplanted rice, 45-51% yield reduction caused by weeds (Veeraputhiran and Balasubramanian, 2013).

In *Rabi* season rice (Sep - Jan), where one rice crop is being grown per year and rest of the period, the fields are left as fallow, weeds grown enormously during off season and poses serious threat in reducing the grain yield of rice. Rainfall during August-September months and soaking of main field during nursery period causes more weeds infestation and multiplication. *Cyperus rotundus* is one of the dominant weeds of sodic soil causes difficulty in land preparation for rice cultivation (Revathi *et al.,* 2017).

In addition, regeneration of *Cyperus* rhizomes and weeds infestation occur during early growth stages of rice due to improper land leveling and alternate wetting and drying irrigation pattern causes more weeds growth, which leads to reduction in yield of rice.

Weed management can be achieved either application of pre emergence or post emergence or combination of both or manual weeding. Hand weeding is an effective method of weed management in transplanted rice, increasing labourer cost and scarcity of labourer during critical period of agricultural operation lead to the search for alternative methods. Hence, pre plant application of herbicide can be used for controlling the emerged weeds particularly *Cyperus* before transplanting which causes easy land preparation and less weeds in the rice field. Chemical method was most effective, economical way of weed management (Suresh kumar and Durairaj, 2016).

Pre plant application of herbicide provide weed free condition during initial stage because it arrest the germination of weeds. In transplanted rice, later emerged weed makes serious problem during critical period of crop weed competition. Hence, use of pre emergence or post emergence herbicides or combination of both is essential for reduce crop weed interference. It is highly essential to control the weeds in transplanted rice through sequential application of herbicides. Very fewer studies have been done on yield attributes and yield transplanted rice using sequential application of herbicides. Hence, present experiment has been carried out to evaluate the sequential herbicide application on yield attributes and yield of transplanted rice.

Materials and Methods

A field experiment was conducted at Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirappalli during *Rabi,* 2018. The total rainfall received during cropping season was 234 mm in 12 rainy days. The mean maximum and minimum temperature

prevailed during the cropping period were 31.8°C and 22.7°C, respectively. The mean relative humidity was 87 and 61 % during forenoon and afternoon, respectively. The mean bright sunshine hours, evaporation and wind velocity were 6.3 hours day^{-1}, 3.3 mm day^{-1} and 3.8 km hr^{-1}, respectively.

The soil of the experimental field was alkaline in nature (pH-9.1), sandy clay loam in texture, moderately drained and classified as *Vetric Ustropept.* The experimental soil was low in available nitrogen (112.9 kg ha^{-1}), medium in available phosphorus (14.2 kg ha^{-1}) and high in available potassium (288.4 kg ha^{-1}).

The experiment was laid out in split plot design with four main plot and five sub plot treatments and replicated thrice. The experimental plot size was 20 m^2. Main plot treatments were pre plant application of herbicides namely glyphosate 2.5 kg ha^{-1}, glufosinate ammonium 1.0 kg ha^{-1}, halosulfuron methyl 67.5 g ha^{-1} and control.

Sub plot treatments consisted of different weed management practices in transplanted rice namely, pre emergence application of bensulfuron methyl + pretilachlor 660 g ha^{-1} on 3 DAT + one hand weeding on 45 DAT, post emergence application of bispyribac sodium 25 g ha^{-1} on 15 DAT + one hand weeding on 45 DAT, application of bensulfuron methyl + pretilachlor 660 g ha^{-1} on 3 DAT + bispyribac sodium 25 g ha^{-1} on 25 DAT, hand weeding twice at 25 and 45 DAT and unweeded control.

Pre plant herbicides sprayed 15 days before puddling. The rice variety TRY 3 was grown during the course of investigation. All the agronomic practises and plant protection measures were adopted as per the recommended package of Tamil Nadu Agricultural University, Coimbatore (CPG, 2012).

Yield attributes and yield

Yield parameters and yield were recorded at harvest.

Productive tillers

Productive tillers were counted using quadrates at randomly from each net plot and expressed in numbers per m^2.

Panicle length

Panicle length was measured in randomly selected ten panicles and denoted as cm.

Total grains $panicle^{-1}$

Randomly selected ten panicles used for counting total grains $panicle^{-1}$and denoted as total grains $panicle^{-1}$.

Number of filled grains $panicle^{-1}$

Number of filled grains $panicle^{-1}$were counted from the randomly selected ten panicles and denoted as filled grains $panicle^{-1}$.

Test weight

Thousand filled grains were counted and weighed at 14 % moisture and denoted in g.

Grain yield

Grains harvested from the net plot area was thrashed, cleaned, sun dried and weighed at 14 % moisture and expressed as kg ha^{-1}.

Straw yield

Paddy straw from net plot was sun dried, weighed and denoted as kg ha-^{1}.

Harvest Index (HI)

HI (%)
$= \text{Grain yield (Kg ha}^{-1}) / \text{Biological yield (Kg ha}^{-1})$

Where, Biological yield = Grain yield (Kg ha^{-1}) + Straw yield (Kg ha^{-1})

Statistical analysis

The data were statistically analysed following the procedure given by Panse and Sukhatme (1967) for split plot design. CD at 5 % probability was calculated.

Weed flora

Common weed species observed in the field during the course of investigation were *Echinochloa colona* (L.), *Cynodon dactylon* (L.) in grasses, *Cyperus rotundus* (L.) in sedges and *Eclipta alba* (L.), *Euphorbia prostrata* (L.), *Lippia nodiflora* (L.) in broad leaved weeds (Fig 1). Before spraying of pre plant herbicides, sedges (71 %) was found to be the predominant category followed by grasses (18 %) and broad leaved weeds (BLW) (11 %). *Cyperus rotundus* is one of the dominant weed in sodic soil environment and similar weed species have been found in transplanted rice under sodic soil (Revathi *et al.,* 2017). In transplanted rice, grasses (65.4 %) was the dominant weed, followed by sedges (30.1 %) and BLW (4.5 %) at 60 DAT in absolute control. This might be due to pre plant application of glyphosate and glufosinate ammonium completely destroyed the weeds before transplanting and also reduced the weeds germination as well as re-growth of *Cyperus* in rice field.

Yield attributes

All the weed management treatments showed significant variation in the yield attributes of transplanted rice (Table 1). Spraying of glyphosate 2.5 kg ha^{-1} produced significantly more productive tillers (350 m^{-2}), Panicle length (24.4 cm), filled grains (153 $panicle^{-1}$) and total grains (171 $panicle^{-1}$) than halosulfuron methyl and control. Application glyphosate 2.5 kg ha^{-1} at 15 days before puddling controlled all the weeds including *Cyperus*, the most problematic weed of wet land rice. Further, complete drying and incorporation of weeds during puddling would have reduced the weed germination, led to very few weeds encountered after transplanting of rice. In addition, lower nutrient removal by weeds and higher nutrient uptake by crop at early stages improved the plant growth parameters and ultimately higher yield attributes. These findings are in accordance with findings of Parthipan and Ravi (2016). However, it was comparable with glufosinate ammonium 1.0kg ha^{-1}. Application halosulfuron methyl 67.5 g ha^{-1} resulted significantly lesser productive tillers (281 m^{-2}), Panicle length (22.5 cm), filled grains (137 $panicle^{-1}$), total grains (161 $panicle^{-1}$) and was comparable with control.

Among the sub plot treatments, post emergence application of bispyribac sodium 25 g ha^{-1} + hand weeding on 45 DAT resulted significantly more productive tillers (338 m^{-2}), Panicle length (24.7 cm), filled grains (159 $panicle^{-1}$), total grains (179 $panicle^{-1}$) and was comparable with pre emergence application of bensulfuron methyl + pretilachlor 660 g ha^{-1} + post emergence application of bispyribac sodium 25 g ha^{-1} on 25 DAT and hand weeding twice at 25 and 45 DAT. Bispyribac sodium as a post emergence herbicide, controlled broad spectrum of weeds including grasses, sedges and broadleaved weeds through acetolactate synthase mode of action, during critical period of crop weed competition. Second flush of weeds may removed by manual weeding at 45 DAT resulted in lesser crop weed competition, increased nutrient availability to crop favored

better source sink relationship and ultimately more of yield attributes. Bensulfuron methyl + pretilachlor 660 g ha^{-1} + hand weeding on 45 DAT recorded lesser number of productive tillers (314 m^{-2}), Panicle length (22.6 cm), filled grains (142 $panicle^{-1}$) and total grains (162 $panicle^{-1}$). Unweeded control obtained significantly lower number of yield attributes.

This might be due to poor interception of light as well as lesser nutrient available to plants resulted in poor photosynthesis and photochemical energy supply which ultimately affected the translocation of photosynthates to the developing grains (Mandhata singh and Singh, 2010).

Thousand grain weight of rice was not significantly differed with different pre plant as well as rice weed management practices.

Yield

Adoption of different weed control practices produced distinct variations in grain as well as straw yield of transplanted rice (Table 2). Among the pre plant herbicides, glyphosate 2.5 kg ha^{-1} produced significantly higher grain yield (4232 kg ha^{-1}) and straw yield (6986 kg ha^{-1}) over halosulfuron methyl and control. The increment in grain and straw yields were mainly due to that application of glyphosate 2.5 kg ha^{-1} at 15 days before puddling controlled all the weeds including *Cyperus* by inhibiting5-enolpyruvylshikimate-3-phosphate (EPSP) synthase pathway that required for protein synthesis. Further, complete drying and incorporation of weed during puddling would have reduced the weed germination resulted in lesser crop weed competition and higher weed control efficiency. These conditions favored better crop growth and yield parameters which ultimately increased the grain and straw yield of rice. These results are similar with findings of Veeraputhiran and Balasubramanian (2010), who reported that application of glyphosate at 15 days before transplanting registered higher grain and straw yields in rice. However, this was comparable with glufosinate ammonium 1.0 kg ha^{-1} (4145 and 6708 kg ha^{-1} grain and straw yield, respectively). Glufosinate inhibited the activity of glutamine synthase, the enzyme that essential for conversion of glutamate plus ammonium to glutamine. Accumulation of ammonia in the plant, that leads to destroys cells directly and inhibits photosystem I and II reactions, caused complete drying of weeds including *Cyperus* within 7 days after application, resulted in less weed density and competition favored better crop growth and yield. Halosulfuron methyl 67.5 g ha^{-1} resulted significantly lower grain yield (3959 kg ha^{-1}) and straw yield (6560 kg ha^{-1}) than glyphosate. The reason behind lesser grain yield was poor control of weeds particularly *Cyperus rotundus*. Halosulfuron methyl effectively control the *Cyperus* at 3-4 leaf stage only and in this experimental field, *Cyperus* was present in flowering to maturity stage. These findings are in accordance with Mritunjaykumar (2018), who reported that foliar application of halosulfuron methyl 75 % WG was given at 3-4 leaf stage of *Cyperus rotundus* for effective control. Lesser grain yield (3565 kg ha^{-1}) and straw yield (6337 kg ha^{-1}) was registered with control plot.

Weed management practices imposed in transplanted rice significantly altered the grain yield and straw yield. Among the post plant weed management practices, post emergence application of bispyribac sodium 25 g ha^{-1} + hand weeding on 45 DAT registered significantly more grain yield (4327 kg ha^{-1}) over unweeded control. However, this was comparable with bensulfuron methyl + pretilachlor 660 g ha^{-1} + bispyribac sodium 25 g ha^{-1} on 25 DAT (4299 kg ha^{-1}), hand weedingtwice at 25 and 45 DAT (4187 kg ha^{-1}) and pre emergence application of bensulfuron methyl + pretilachlor 660 g ha^{-1} on 3 DAT + hand weeding on 45 DAT(4143 kg ha^{-1}).

Table.1 Evaluation of different weed management practices on yield attributes of transplanted rice.

Treatments	Productive tillers (m^{-2})	Panicle length (cm)	Total grains panicle^{-1}	No. of filled grains panicle^{-1}	Test weight (g)
Main plots (Pre plant herbicides)					
M_1 - Glyphosate 2.5 kg ha^{-1}	350	24.4	171	153	24.5
M_2 - Glufosinate ammonium 1.0 kg ha^{-1}	331	23.6	169	146	24.2
M_3 - Halosulfuron methyl 67.5 g ha^{-1}	281	22.5	161	137	23.9
M_4 – Control	263	21.7	157	131	24.0
SEd	8	0.64	3	4	0.40
CD (P=0.05)	20	1.58	8	9	NS
Sub plots (Weed management in rice)					
S_1 - PE bensulfuron methyl + pretilachlor 660 g ha^{-1} + HW on 45 DAT	314	22.6	162	142	24.3
S_2 - POE bispyribac sodium 25 g ha^{-1} + HW on 45 DAT	338	24.7	179	159	24.6
S_3 - PE bensulfuron methyl + pretilachlor 660 g ha^{-1} + POE bispyribac sodium 25 g ha^{-1}	329	23.9	169	150	24.0
S_4 - HW on 25 and 45 DAT	318	23.2	167	146	23.9
S_5 - Unweeded control	233	20.8	144	116	24.7
SEd	10	0.55	6	6	0.41
CD (P=0.05)	21	1.12	13	13	NS

* Interaction non-significant PE- Pre emergence POE- Post emergence HW- Hand weeding

Fig.1 Weed flora of the experimental field.

Table.2 Evaluation of different weed management practices on grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and harvest index (%) of transplanted rice.

Treatments	Grain yield	Straw yield	Harvest index
Main plots (Pre plant herbicides)			
M_1 - Glyphosate 2.5 kg ha^{-1}	4232	6986	0.38
M_2 - Glufosinate ammonium 1.0 kg ha^{-1}	4145	6708	0.38
M_3 - Halosulfuron methyl 67.5 g ha^{-1}	3959	6560	0.37
M_4 – Control	3565	6337	0.36
SEd	110	163	0.002
CD (P=0.05)	269	399	0.006
Sub plots (Weed management in rice)			
S_1 - PE bensulfuron methyl + pretilachlor 660 g ha^{-1} + HW on 45 DAT	4143	6963	0.37
S_2 - POE bispyribac sodium 25 g ha^{-1} + HW on 45 DAT	4327	6835	0.39
S_3 - PE bensulfuron methyl + pretilachlor 660 g ha^{-1} + POE bispyribac sodium 25 g ha^{-1}	4299	7174	0.37
S_4 - HW on 25 and 45 DAT	4187	6850	0.38
S_5 - Unweeded control	2923	5416	0.35
SEd	101	178	0.009
CD (P=0.05)	206	362	0.018

* Interaction non-significant PE- Pre emergence POE- Post emergence HW- Hand weeding

The combination of two herbicides or one herbicide followed by one manual weeding controlled the weeds both first flush as well as later emerged weeds. This corroborating with the findings of Sureshkumar and Durairaj (2016). Bispyribac sodium 25 g ha^{-1} interfered with production of a plant enzyme necessary for growth and development named acetolactate synthase (ALS) led to effectively controlled the emerged weeds during critical stages and maintain the crop free from crop weed competition resulted in lesser competition by weeds for nutrients, space and light ultimately increased plant height, tiller number, productive tillers, filled grains, DMP, LAI and finally grain yield. These results are in line with findings of Prashanth *et al.*, (2015), who reported that post emergence application of bispyribac sodium at 25 g ha^{-1} at 15 DAT recorded significantly higher grain yield in transplanted rice. Lesser grain yield (2923 kg ha^{-1}) was recorded under unweeded control.

Pre emergence application of bensulfuron methyl + pretilachlor 660 g ha^{-1} + post emergence application of bispyribac sodium 25 g ha^{-1} on 25 DAT significantly registered higher straw yield of 7174 kg ha^{-1} than control and was statistically comparable with pre emergence application of bensulfuron methyl + pretilachlor 660 g ha^{-1} + hand weeding on 45 DAT (6963 kg ha^{-1}), hand weeding twice at 25 and 45 DAT (6850 kg ha^{-1}) and post emergence application of bispyribac sodium 25 g ha^{-1} + HW on 45 DAT (6835 kg ha^{-1}). Unweeded control registered the lower straw yield of 5416 kg ha^{-1}. This is mainly because

of severe crop weed competition during throughout the crop period. Same findings were reported by Parthipan and Subramanian (2013).

Harvest index (HI)

Harvest index of transplanted rice significantly influenced by pre plant application of herbicides and rice weed management practices (Table 2). Glyphosate 2.5 kg ha^{-1} and glufosinate ammonium 1.0kg ha^{-1} registered significantly similar value of HI (0.38 %) over control. However, this was on par with halosulfuron methyl 67.5 g ha^{-1} (0.37 %). Control obtained lesser harvest index of 0.36 %. Among the sub plot treatments, post emergence application of bispyribac sodium 25 g ha^{-1} + hand weeding on 45 DAT registered significantly higher harvest index (0.39 %) than control. However, it was statistically on par with hand weeding twice on 25 and 45 DAT (0.38 %), pre emergence application of bensulfuron methyl + pretilachlor 660 g ha^{-1} + post emergence application of bispyribac sodium 25 g ha^{-1} on 25 DAT (0.37 %) andpre emergence application of bensulfuron methyl + pretilachlor 660 g ha^{-1} + hand weeding on 45 DAT (0.37 %). Unweeded control obtained lower harvest index (0.35 %).

Hence, it could be concluded from the field study, pre plant application of glyphosate 2.5 kg ha^{-1} at 15 days before puddling followed by post emergence application of bispyribac sodium 25 g ha^{-1} on 15 DAT + hand weeding on 45 DAT found higher yield attributes and yield in transplanted rice.

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