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Assessment of Weed Dynamics and Crop Response Through Integrated Weed Management Strategies in Drum Seeded Rice

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ABSTRACT

Background: A field trial was carried out during the *Navarai* season (Jan - Apr) of 2025 at the wetland Farm of SRM College of Agricultural Sciences, located in Baburayanpettai, Chengalpattu, Tamil Nadu, India to assess the effect of integrated weed management strategies in drum-seeded rice.

Methods: The experiment was laid out in randomized block design (RBD) consisting of ten treatments with three replications. The treatments comprised combinations of Bensulfuron methyl + Pretilachlor (PE), Trifamone + Ethoxysulfuron (EPoE), Florpyrauxifen-benzyl + Cyhalofop-butyl (POE), in combination of hand weeding and power weeding.

Result: Findings indicated that applying PE Bensulfuron methyl + Pretilachlor (660 g/ha) followed by POE Florpyrauxifen-benzyl + Cyhalofop-butyl (150 g/ha) significantly reduced weed density, enhancing weed control efficiency and growth parameters like plant height, tiller count and panicle characteristics and also resulted in the highest straw yield (7215 kg/ha) and grain yield (5,550 kg/ha). The research concludes that employing combination of pre and post emergence herbicides represents a *via*ble approach for effective weed control and enhanced productivity in drum-seeded rice.

Key words: Bensulfuron methyl + Pretilachlor (PE), Drum seeded rice, Florpyrauxifen-benzyl + Cyhalofop-butyl (POE), Paddy power weeder, Trifamone + Ethoxysulfuron (EPoE).

INTRODUCTION

Rice is one of the most important staple food crops for Asia and several countries in the world. Rice is grown globally on approximately 168.36 million hectares, producing about 799.99 million tonnes with an average yield of 4.7 tonnes per hectare (FAOSTAT, 2023). In India, rice is one of the most important crops occupying an area of 47.82 million hectares with the production of 137.82 million tonnes and having an average yield of 2.8 t/ha. In Tamil Nadu, total area of rice production was 21.01 lakh hectares, production was 67.99 lakh tonnes and productivity were 3235 kg/ha (Indiastat, 2024).

Increasing water scarcity, reduced labours and rice crop's water loving character tend the farmers to look for an alternate method of cultivation. Direct seeded rice was able to reduce water usage and increase the water productivity (Kaur and Singh, 2017). At the present situation, transplanted rice has been replaced by the direct seeded rice which increases intensity of grasses than the broad-leaved weeds (Selvaraj and Hussainy, 2020). Due to continuous process of puddling in traditional transplanted rice, aggregates of the soil reduce which damages the stability creating hardpans which can be rectified by the direct seeded rice (Mir *et al.,* 2023). Utilizing a drum seeder for direct wet seeding of rice offers numerous advantages, such as avoiding the nursery preparation and transplanting stages, facilitating faster and more straight forward planting and reducing water and labor requirements. This technique speeds up the crop maturity and improves water usage efficiency, resulting in a reduction of approximately 25% (250-300-man hours) in the total labor required for rice nursery preparation and transplanting, thus making rice production more financially sustainable (Raghavendra *et al.,* 2015).

Despite the advantages, the main problem with direct seeded rice is weed infestation which is a major potential threat to rice crop. The absence of flooded water at the

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premature time of cultivation increases weeds in direct seeded rice (Shekhawat *et al.,* 2022 and Ashraf *et al.,* 2024). To control the weeds, single weed management strategy won't be effective. So integrated weed management strategies should be used to eliminate the weeds. The effectiveness of DSR largely relies on improved weed management techniques. Several research findings indicate that relying on either pre- or post-emergence herbicides alone does not achieve adequate weed control during the growing season. In this regard, applying combination of pre-and post-emergence herbicides or combination with physical and mechanical methods was more efficient approach (Yogananda *et al.,* 2021 and Vasantha Kokilam *et al.,* 2023). Considering these factors, the impact of different herbicides and non-chemical methods was assessed against weedy controls to evaluate their effectiveness and achieve greater yields in drum-seeded rice.

MATERIALS AND METHODS

The experiment was carried out during the *Navarai* season (Jan. - Apr.) of year 2025 at the wetland farm of SRM college of Agricultural sciences, Baburayanpettai, Chengalpattu district, Tamil Nadu, India. The coordinates of the experimental site are 12.38° N latitude and 79.73° E longitude at the elevation of 50m above mean sea level. This site is classified as part of the North Eastern agro-climatic zone in Tamil Nadu, India. Prior to the experiment, the NPK levels measured were 217.4 kg/ha (low nitrogen), 12.8 kg/ha (medium phosphorus) and 140.3 kg/ha (medium potassium), respectively. The average pH was about 6.5 - 7.5 which is neutral and EC was 0.47 dsm^{-1} which is low. The experimental design was laid out in randomized block design (RBD) and replicated thrice. The treatment details are T_1- PE Bensulfuron methyl + Pretilachlor @ 660 g/ha *fb* Hand weeding on 40 DAS, T_2- PE Bensulfuron methyl + Pretilachlor @ 660 g/ha *fb* Power weeding on 40 DAS, T_3- PE Bensulfuron methyl + Pretilachlor @ 660 g/ha *fb* PoE Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g/ha, T_4- EPoE Trifamone + Ethoxysulfuron @ 67.5 g/ha on *fb* Hand weeding on 40 DAS, T_5- EPoE Trifamone + Ethoxysulfuron @ 67.5 g/ha *fb* Power weeding on 40 DAS, T_6- EPoE Trifamone + Ethoxysulfuron @ 67.5 g/ha *fb* Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g/ha, T_7- PE Pretilachlor @ 500 g/ha on *fb* Hand weeding on 40 DAS, T_8- Power weeding @ 20 DAS and 40 DAS, T_9- Hand weeding @ 20 DAS and 40 DAS and T_{10}- Control.

The rice variety CO 55 was sown using the drum seeder (Fig 1 and 2). Pre emergence herbicide was applied at 3 DAS mixed with sand by maintaining a thin

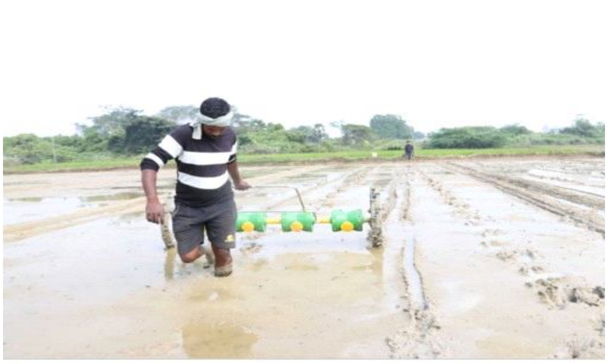

Fig 1: Sowing with drum seeder.

Fig 2: Dispense the sprouted paddy seeds evenly in the puddled field at the line spacing of 20 cm.

Fig 3: Spraying of post emergence herbicides on 10 DAS.

Fig 4: Paddy power weeder operated weeding on 40 DAS.

film of water. The early post-emergence and post-emergence were applied at 10 DAS and 25 DAS respectively, through a knapsack sprayer (Fig 3). The mechanical weeding was carried out as per the schedule using a two-row paddy power weeder (Fig 4). Hand weeding takes place as per the treatment schedule (Fig 5). All the package of practices were followed based on CPG (2020).

The observation on weeds *viz.* total weed density and weed control efficiency were recorded at 20, 40 and 60 DAS using a (0.5 $\times$ 0.5 m) quadrant randomly in 4 places in a plot. The growth parameters *viz.*, plant height (cm), number of tillers and the yield attributes *viz.,* the number of productive tillers, filled grains panicle^{-1}, grain yield (kg/ha) and straw yield (kg/ha) was recorded. For the observations related to weeds, a transformation of square root ($\sqrt{x+0.5}$) was applied to the values prior to performing analysis statistically to achieve normalization of their distribution. The statistical evaluation was conducted based on the mean values obtained. The statistical package used for analysis was R studio. A significance level of P = 0.05 was utilized for the 'F' and 't' tests. Whenever the 'F' test was found to be significant, critical difference values were computed following the methodology described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Weed density

The total weed density was significantly reduced among the various weed control treatments. In the treatments, hand weeding twice at 20 and 40 DAS recorded the lowest weed density (5.38 no/m^2) at 20 DAS. This was followed by PE Bensulfuron methyl + Pretilachlor @ 660 g/ha *fb* PoE Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g/ha with 6.12 no./m^2. The highest weed density was observed in control with 12.30 no./m^2.

At the 40 and 60 DAS, PE Bensulfuron methyl + Pretilachlor @ 660 g/ha *fb* PoE Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g/ha (Fig 6 and 7) consistently showed the least amount of weed density of 6.07 and 6.64 no./m^2, respectively. This shows the effectiveness of both pre-emergence and post-emergence herbicides for weed management. This was followed by EPoE Trifamone + Ethoxysulfuron @ 67.5 g/ha *fb* Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g/ha (Table 1). Control plot recorded the highest weed density with 14.02 and 15.17 no./m^2 respectively (Fig 8). These findings correlate with Singh *et al.,* 2018. Grasses were strong competitors, depleting a larger share of the available nutrients and leading over sedges and broad-leaved weeds (Suaganya, 2024). As pre-

Fig 5: Hand weeding on 40 DAS.

Fig 7: Crop stand of PE Bensulfuron methyl + Pretilachlor followed by PoE Florpyrauxifen-benzyl + Cyhalofop-butyl at maturity stage.

Fig 6: Crop stand of PE Bensulfuron methyl + Pretilachlor followed by PoE Florpyrauxifen-benzyl + Cyhalofop-butyl at 60 DAS.

Fig 8: Weed infestation in control (weedy check).

emergence application of bensulfuron methyl at less dosage found to be effective in controlling the broad leaves and sedges effectively. On other hand, application of pretilachlor at early stages reduces the grasses. Thus, pre mix combination of these chemicals-controlled weeds effectively (Negalur and Halepyati, 2016). The increased effectiveness of herbicides observed with drum seeding could be attributed to the quick emergence of weeds, during which the majority of these weeds were impacted by the herbicides (Singh and Singh 2010 and Mullaivendhan *et al.,* 2024).

Weed control efficiency

The effectiveness of weed control (WCE) showed significant variations among the different treatments (Table 2). The highest WCE was obtained in treatment of hand weeding @ 20 and 40 DAS with 82.87%, which was closely followed by PE bensulfuron methyl + pretilachlor @ 660 g/ha *fb* PoE florpyrauxifen-benzyl + cyhalofop-butyl @ 150 g/ha with a WCE of 77.31%, indicating strong early-stage weed suppression achieved through manual or well-timed chemical interventions. In contrast, power weeding at 20 and 40 DAS showed the lowest weed control efficacy (WCE) at 46.36 %, indicating that mechanical weeding alone has had limited effectiveness during this initial stage of crop growth.

In the final phases of crop development (40 and 60 DAS), PE Bensulfuron methyl + Pretilachlor @ 660 g/ha *fb* PoE Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g/ha consistently achieved the most effective weed control hitting 83.04% at 40 DAS and 82.40% at 60 DAS (Table 3). EPoE Trifamone + Ethoxysulfuron @ 67.5 g/ha fb Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g/ha on 25 DAS also showed high efficiency (76.65% and 74.99%), indicating that the consecutive use of both pre-and post-emergence herbicides had the efficient weed management. The consistent effectiveness of these treatments can be linked to the sequential use of herbicides aimed at various weed flushes, providing extended residual effects and minimizing weed competition over the season. These findings were in line with Hia *et al.* (2017) and Mullaivendhan *et al.* (2024). The greatest effectiveness in weed control was noted in plots treated with pre-emergence followed by post-emergence applications.

Crop growth and yield

Among the different treatments, applying PE Bensulfuron methyl + Pretilachlor @ 660 g/ha on *fb* PoE Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g/ha on resulted in the taller plant height (78.80 cm), significantly outperforming all other treatments. The control plot had the shortest plant height at 57.40 cm. The combination of PE bensulfuron methyl + pretilachlor at 660 g/ha followed by PoE

Table 1: Effect of different weed management practices on total weed density (no./m^2) in drum seeded rice.

Treatments	20 DAS	40 DAS	60 DAS
T_1: PE Bensulfuron methyl + Pretilachlor @ 660 g a.i/ha on 3 DAS *fb* Hand weeding on 40 DAS	6.07 (31.01)	7.64 (50.97)	8.27 (60.31)
T_2: PE Bensulfuron methyl + Pretilachlor @ 660 g a.i/ha on 3 DAS *fb* Power weeding on 40 DAS	6.18 (32.23)	8.99 (72.10)	9.75 (85.67)
T_3: PE Bensulfuron methyl + Pretilachlor @ 660 g a.i/ha on 3 DAS *fb* PoE Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g a.i/ha on 25 DAS	6.12 (31.56)	6.07 (31.00)	6.64 (37.66)
T_4: EPoE Trifamone + Ethoxysulfuron @ 67.5 g a.i./ha on 10 DAS *fb* Hand weeding on 40 DAS	6.43 (35.18)	8.09 (57.72)	8.44 (63.13)
T_5: EPoE Trifamone + Ethoxysulfuron @ 67.5 g a.i./ha on 10 DAS *fb* Power weeding on 40 DAS	6.36 (34.33)	9.53 (81.67)	10.42 (98.53)
T_6: EPoE Trifamone + Ethoxysulfuron @ 67.5 g a.i./ha on 10 DAS *fb* Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g a.i/ha on 25 DAS	6.38 (34.54)	7.03 (42.68)	7.77 (52.86)
T_7: PE Pretilachlor @ 500 g a.i/ha on 3 DAS *fb* Hand weeding on 40 DAS	6.52 (36.22)	8.26 (60.28)	8.79 (68.92)
T_8: Power weeding @ 20 DAS and 40 DAS	9.14 (74.65)	10.28 (95.67)	10.94 (108.96)
T_9: Hand weeding @ 20 DAS and 40 DAS	5.38 (23.80)	8.50 (64.17)	9.22 (76.08)
T_{10}: Control	12.30 (139.36)	14.02 (182.81)	15.17 (215.92)
SEd	0.33	0.23	0.36
CD @ 5%	0.60	0.42	0.66

(*Data is subjected to square root transformation. Values in the parenthesis are original
PE- Pre emergence; PoE- Post emergence; EPoE- Early post emergence; fb- followed by).

Florpyrauxifen-benzyl + Cyhalofop-butyl at 150 g/ha also recorded the highest number of tillers (506/m^2), with EPoE Trifamone + Ethoxysulfuron at 67.5 g/ha followed by Florpyrauxifen-benzyl + Cyhalofop-butyl at 150 g/ha (473/m^2). The control plot showed the lowest tiller count at 220/m², which was significantly lower than that of all other treatments. The highest number of grains per panicle was noted with the treatment of PE Bensulfuron methyl + Pretilachlor at 660 g/ha followed by PoE Florpyrauxifen-benzyl + Cyhalofop-butyl at 150 g/ha (115.6), followed by

Table 2: Effect of different weed management practices on weed control efficiency (%) in drum seeded rice.

Treatments		20 DAS	40 DAS	60 DAS
T_1:	PE Bensulfuron methyl + Pretilachlor @ 660 g a.i/ha on 3 DAS *fb* Hand weeding on 40 DAS	77.73	72.12	71.66
T_2:	PE Bensulfuron methyl + Pretilachlor @ 660 g a.i/ha on 3 DAS *fb* Power weeding on 40 DAS	76.86	60.56	59.62
T_3:	PE Bensulfuron methyl + Pretilachlor @ 660 g a.i/ha on 3 DAS *fb* PoE Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g a.i/ha on 25 DAS	77.31	83.04	82.40
T_4:	EPoE Trifamone + Ethoxysulfuron @ 67.5 g a.i./ha on 10 DAS *fb* Hand weeding on 40 DAS	74.68	68.41	70.12
T_5:	EPoE Trifamone + Ethoxysulfuron @ 67.5 g a.i./ha on 10 DAS *fb* Power weeding on 40 DAS	75.31	55.34	53.51
T_6:	EPoE Trifamone + Ethoxysulfuron @ 67.5 g a.i./ha on 10 DAS *fb* Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g a.i/ha on 25 DAS	75.18	76.65	74.99
T_7:	PE Pretilachlor @ 500 g a.i/ha on 3 DAS *fb* Hand weeding on 40 DAS	73.95	67.01	68.00
T_8:	Power weeding @ 20 DAS and 40 DAS	46.36	47.66	48.54
T_9:	Hand weeding @ 20 DAS and 40 DAS	82.87	64.87	64.26
T_{10}:	Control	0.00	0.00	0.00

(*This parameter is not statistically analysed, PE- Pre emergence; PoE- Post emergence; EPoE- Early post emergence; fb- followed by).

Table 3: Effect of different weed management practices on growth parameters and yield attributes in drum seeded rice.

Treatments		Plant height (cm)	No. of tillers/m^2	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1:	PE Bensulfuron methyl + Pretilachlor @ 660 g a.i/ha on 3 DAS *fb* Hand weeding on 40 DAS	71.00	440	4772	6346
T_2:	PE Bensulfuron methyl + Pretilachlor @ 660 g a.i/ha on 3 DAS *fb* Power weeding on 40 DAS	64.60	368	4012	5697
T_3:	PE Bensulfuron methyl + Pretilachlor @ 660 g a.i/ha on 3 DAS fb PoE Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g a.i/ha on 25 DAS	78.80	506	5550	7215
T_4:	EPoE Trifamone + Ethoxysulfuron @ 67.5 g a.i./ha on 10 DAS fb Hand weeding on 40 DAS	69.10	431	4440	5949
T_5:	EPoE Trifamone + Ethoxysulfuron @ 67.5 g a.i./ha on 10 DAS fb Power weeding on 40 DAS	62.10	353	3862	5599
T_6:	EPoE Trifamone + Ethoxysulfuron @ 67.5 g a.i./ha on 10 DAS fb Florpyrauxifen-benzyl + Cyhalofop-butyl @ 150 g a.i/ha on 25 DAS	71.90	473	5128	6720
T_7:	PE Pretilachlor @ 500 g a.i/ha on 3 DAS fb Hand weeding on 40 DAS	67.80	409	4262	5711
T_8:	Power weeding @ 20 DAS and 40 DAS	60.40	337	3312	4968
T_9:	Hand weeding @ 20 DAS and 40 DAS	65.87	393	4110	5671
T_{10}:	Control	57.40	220	1246	2055
SEd		3.58	18	182	263
CD @ 5%		6.57	34	333	483

EPoE Trifamone + Ethoxysulfuron at 67.5 g/ha followed by Florpyrauxifen-benzyl + Cyhalofop-butyl at 150 g/ha (106.4). The control plot recorded the lowest grains, at 88.2. The higher grain output was attained through the use of PE Bensulfuron methyl + Pretilachlor at 660 g/ha followed by PoE Florpyrauxifen-benzyl + Cyhalofop-butyl at 150 g/ha (5,550 kg/ha), which was notably higher than that of the other treatments. A yield of 5,128 kg/ha was also noted for EPoE Trifamone + Ethoxysulfuron at 67.5 g/ha followed by Florpyrauxifen-benzyl + Cyhalofop-butyl at 150 g/ha, which also performed well. The control recorded the least yield at 1,246 kg/ha. Straw yield reflected a similar pattern, with PE Bensulfuron methyl + Pretilachlor at 660 g/ha followed by PoE Florpyrauxifen-benzyl + Cyhalofop-butyl at 150 g/ha achieving the highest straw yield (7215 kg/ha), while EPoE Trifamone + Ethoxysulfuron at 67.5 g/ha followed by Florpyrauxifen-benzyl + Cyhalofop-butyl at 150 g/ha yielded 6720 kg/ha (Table 3). The control plot had the lowest straw yield at 2055 kg/ha. The presence of weeds adversely affected the growth and yield characteristics of the crop, ultimately leading to a decrease in the grain yield of direct-seeded rice (Saravanane, 2020 and Saravana Perumal *et al.,* 2025). Lower weed density in the plots treated with chemicals enabled the crops to grow more effectively due to the reduced competition from weeds. Enhanced crop growth resulted from reduced competition for water, sunlight, nutrients and space in a weed-free setting. These findings align with the observations of Brar and Bhullar (2017) and Kaur and Singh (2015).

CONCLUSION

Efficient weed management is crucial for enhancing the yield of drum-seeded rice, particularly in situations with limited water and labor availability. Among the various methods evaluated, the sequential treatment of PE Bensulfuron methyl + Pretilachlor (660 g/ha) followed by PoE Florpyrauxifen-benzyl + Cyhalofop-butyl (150 g/ha) was the most effective in controlling weed density as well as increasing weed control efficiency. This approach also led to the greatest plant height, number of tillers, grain yield (5,550 kg/ha) and straw yield (7215 kg/ha). Ultimately, the integration of strategic herbicide applications provides a sustainable and profitable approach for managing weeds in drum-seeded rice.

Conflict of interest

All authors declared that there is no conflict of interest.

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