Effect of integrated weed management practices on weed indices in rice (*Oryza sativa*) under SRI

ABSTRACT

A field experiment was carried out at the Annamalai University Experimental Farm, Cuddalore District, Tamil Nadu, from February to May 2023. The treatments included the best combinations consisting of chemical and mechanical methods of weed control. The experiment was laid out in a randomised block design with seven treatments and replicated three times. Among the different treatments, Penoxsulam + Butachlor @ 2L/ha (PE) on 3 DAT fb, Conoweeder twice on 25 and 35 DAT(rice) (T_3), which helps in reducing weed density and ultimately reduced weed biomass, resulted in an increase in crop growth and yield. Higher plant height, DMP, and higher green cob yield were recorded under (T_3) might be due to maintenance of a weed-free environment, particularly throughout vital growth stages of crop. Cutback crop weed competition helped in higher growth and development of rice crop, leading to higher grain and straw yield.

KEYWORDS: Integrated weed management, SRI, conoweeder, rice, penoxsulam, butachlor.

INTRODUCTION

Globally, rice is cultivated over an area of 162 million hectares, with an annual production of around 700 million metric tonnes and an average productivity of 4.3 metric tonnes per year. In India, rice is cultivated on an area of 48.53 million hectares, with a production of 112.18 million metric tonnes and an average productivity of 2.31 metric tonnes ha^{-1}. In Tamil Nadu, rice is cultivated on an area of 2.2 million hectares with a production of 8.65 million

metric tonnes and a productivity of 3.93 t ha^{-1} (Directorate of Economics and Statistics, 2021). To feed the exploding population, the projection of India's rice production target for 2035 AD is 135 million metric tonnes, which can be achieved only by increasing rice production by over 2.0 million metric tonnes per year in the coming decade.

The system for rice intensification (SRI) was developed by French priest Father Henri de Laulani in Madagascar in the 1980s in an effort to find sustainable agricultural practices that lead to higher productivity, optimum use of capital and labour, less input cost, and less requirement of water. System of rice intensification (SRI) is an acronym that is defined as “system for rice intensification”. The System of Rice Intensification (SRI) is a way of harmonising the elements of soil, water, light, and plant to allow the plant to achieve its fullest potential, which is often hidden when inappropriate techniques are used (Toungos, 2018). As SRI methodology has been validated in over 60 countries, it has become less controversial, and it is becoming part of the operational agricultural landscape, used also by larger-scale farmers and for other crops besides rice (Uphoff *et al*., 2023).

Weeds are the most dangerous terrorist, which causes more yield losses. It influences the crop from germination to harvesting. Most of the weed flora and its density cause higher losses during the initial stages of crop growth. Weed control at a critical period of crop weed competition is economical, and it reduces the cost of chemicals and saves time (Korav*et al.,* 2018).Conoweeder helps to target weeds more accurately, reducing herbicide waste and minimizing drift onto desirable plants (Roy *et al*. 2020).Combining herbicides with conoweeder technology can increase weed control effectiveness, especially for resistant or hard-to-kill species.By precisely applying herbicides directly to weeds, conoweeder can reduce overall

herbicide usage, minimizing environmental impact (Sivakumar *et al*. 2019).Decreased herbicide usage and reduced labourrequirements can lead to significant cost savings for farmers and agricultural professionals.Reduced herbicide usage and targeted application minimize soil and water contamination, promoting a more sustainable agricultural practice (Mohanty *et al*. 2020).

MATERIALS AND METHODS

The field experiment was conducted in field number C2 of the wetland, Annamalai University Experimental Farm, Department of Agronomy, Annamalai Nagar. The experimental farm is situated at $11^0$24' N latitude, $79^0$44' E longitude, and at an altitude of +5.79 m above the mean sea level and 10 km away from the Bay of Bengal sea. The crop season recorded a maximum temperature that ranged from 38.9°C to 28.2°C. The minimum temperature ranged from 16.8°C to 25.7°C. The relative humidity ranged from 62 to 82 percent. The crop period received a rainfall of 178.2 mm, distributed over 7 rainy days during the crop season. The texture of the experimental field soil was clay loam with a pH of 7.0. The soil was low in available nitrogen, medium in available phosphorus, and high in potassium. The experiment used a randomised block design with three replications and seven treatments.

There were seven treatments, *viz.*, T_1 -Weeding with Conoweeder thrice on 15, 25, and 35 DAT, T_2 -Weeding with Conoweeder twice on 15 and 35 DAT, T_3 -Penoxsulam + Butachlor @ 2L/ha (PE) on 3 DAT fb, Conoweeder twice on 25 and 35 DAT, T_4 -Pretilachlor + Pyrazosulfuron ethyl @ 2kg/ha (PE) on 3 DAT fb, Conoweeder twice on 25 and 35 DAT, T_5 - Pretilachlor + Pyrazosulfuron ethyl @ 2kg/ha (PE) on 3 DAT fb, Bispyribac-Na (POE) @ 25g/ha (10 DAT) + Conoweeder on 35 DAT, T_6 - Pretilachlor @ 750g/ha (PE) on 3 DAT fb, Chlorimuron + Metsulfuron @ 8g /ha (POE) on 10 DAT fb Conoweeder on 35 DAT, T_7 -

Unweeded control. Paddy seeds were sown by broadcasting at a rate of 8 kg ha^{-1}. The seeds were treated with *Pseudomonas fluorescens* @ 10 g kg^{-1} of seed and *Azospirillum*@ 600 g ha^{-1} seed for raising nursery. Under the SRI system of rice cultivation, as per the treatment schedule, the required quantity of pre- and early-post-emergence herbicides was sprayed with a knapsack sprayer fitted with a flood jet nozzle using 600 litres of water ha^{-1}. All the pre-emergence, early post-emergence, and post-emergence herbicides were sprayed on 3 DAT and 10 DAT, respectively, with adequate soil moisture. For mechanically weeded plots, conoweeder was given on 15, 25, and 35 DAT, and the same pre-emergence herbicides and early post-emergence were applied as per the treatment schedule. In order to draw a valid conclusion, the weed count data were subjected to as suggested by Gomez and Gomez (1984) before statistical analysis.

RESULTS AND DISCUSSION

Effect on weeds

Seven weed species of rice made up the dominant weed flora in the field experiment, of which three species are grasses, two species are sedges and two species are broad-leaved weeds. The findings revealed that during the early stages of crop growth, grassy weeds predominated over sedge weeds and broad-leaved weeds, but that sedges took control in the later stages. Among grasses, *Echinochloacolonum*, *Echinochloa crus-galli*, *Leptochloa chinensis* andin sedges, *Cyperus rotundus* and *Cyperus iria* and in broad leaved weeds, *Bergia capensis*and *Eclipta alba* were the dominant weed species present in the experimental field. Mohammed *et al*. (2022), Singh *et al*. (2023) and Nath. P *et al*. (2024) reported similar weed flora under transplanted rice.

Effects on total weed count

The perusal of data on weed population on 30 and 60 DAT revealed that weed control through herbicides significantly reduces the weed population over an unweeded plot. The treatment combining penoxsulam + butachlor @ 2L/ha (PE) on 3 DAT fb, conoweeder twice on 25 and 35 DAT, represents a comprehensive integrated weed management (IWM) strategy. This approach integrates both chemical and mechanical weed control methods, which is crucial for effective weed management in rice cultivation. Penoxsulam is a systemic herbicide that effectively controls a wide range of weed species, including grasses, broad-leaved weeds, and sedges. It operates by inhibiting the synthesis of essential amino acids, which are vital for weed growth and development. Its inclusion in the treatment ensures effective post-emergence control of many weed species that may emerge after the application. Butachlor is a pre-emergence herbicide that targets weed seeds and seedlings by inhibiting fatty acid synthesis, thus preventing their germination and early growth. When applied at 2 L/ha, it provides a robust barrier against the establishment of various weed species, especially during the critical early stages of crop growth. These findings support those made by Jena *et al.,* 2019 and Bajwa *et al*., 2020.

Effect on weed biomass

Among the herbicide treatments, penoxsulam + butachlor @ 2L/ha (PE) on 3 DAT fb, conoweeder twice on 25 and 35 DAT recorded the lower weed biomass of 79.2 percent over the control, which represents the effectiveness of the herbicide in controlling weed germination and growth (Fig. 1). Penoxsulam is an acetolactate synthase (ALS) inhibitor, which disrupts the synthesis of essential amino acids, leading to the death of susceptible weeds. Butachlor is a chloroacetanilide herbicide that inhibits cell division and elongation in emerging weed

seedlings.Research has shown that the combination of penoxsulam and butachlor provides broad-spectrum control of grassy and broad-leaved weeds. This combination is particularly effective due to their complementary modes of action, which target different physiological processes in weeds. The Conoweeder is a manually operated tool that uproots weeds between crop rows, disrupting weed growth through mechanical means. Using the Conoweeder on 25 and 35 DAT allows for timely removal of emerging weeds before they become competitive with the crop.Studies have demonstrated that mechanical weeding, when combined with pre-emergence herbicide application, significantly reduces weed biomass and density. The physical removal of weeds by the Conoweeder enhances the overall weed control efficiency and reduces weed dry weight. These findings support those made by Yadav *et al*., 2024.

Effect on weed control index

The proportional distribution of the reduction in weed dry matter production caused by weed control treatments is indicated by the term "weed control index" (WCI). When compared to other treatments, WCI was higher with penoxsulam + butachlor @ 2L/ha (PE) on 3 DAT fb, conoweeder twice on 25 and 35 DAT. This may be because better herbicide distribution on the available interspacing and improved herbicide control of emerging weeds result in the suppression of weeds from the early stages of transplanted rice. The result coincides with the findings of Wang *et al*. (2021).The results of herbicide efficiency index (HEI) were also observed to be superior with the application of penoxsulam + butachlor @ 2L/ha (PE) on 3 DAT fb, conoweeder twice on 25 and 35 DAT than the unweeded control, indicating better efficacy in restricting weeds. These results were found in accord with the findings of Tanveer *et al*. (2019) and Zhang *et al*. (2020).

Table 1: Effect of integrated weed management practices on total weed count (m^{-2}), weed biomass (g m^{-2}) and weed control index on 30 DAT in rice under SRI

Treatments	Total weed count (m^{-2})	Weed biomass (g m^{-2})	WCI
T_1 - Weeding with Conoweeder thrice on 15, 25 and 35 DAT	6.62 (43.45)	10.69 (113.94)	76.86
T_2 - Weeding with Conoweeder twice on 15 and 35 DAT	6.64 (43.68)	10.84 (117.07)	75.92
T_3 - Penoxsulam + Butachlor @ 2L/ha (PE) on 3 DAT fb, Conoweeder twice on 25 and 35 DAT	3.46 (11.48)	7.74 (59.40)	90.68
T_4 - Pretilachlor + Pyrazosulfuron ethyl @ 2kg /ha (PE) on 3 DAT fb, Conoweeder twice on 25 and 35 DAT	5.07 (25.21)	8.40 (70.15)	86.35
T_5 - Pretilachlor + Pyrazosulfuron ethyl @ 2kg /ha (PE) on 3 DAT fb, Bispyribac-Na (POE) @ 25g /ha (10 DAT) + Conoweeder on 35 DAT	5.09 (25.43)	8.53 (72.28)	84.72
T_6 - Pretilachlor @ 750g /ha (PE) on 3 DAT fb, Chlorimuron + Metsulfuron @ 8g /ha (POE) on 10 DAT fb Conoweeder on 35 DAT	6.22 (38.17)	9.16 (83.34)	80.86
T_7 - Unweeded control	10.10 (101.53)	16.92 (285.89)	-
S.Ed	**0.14**	**0.24**	-

CD (P = 0.05)	**0.31**	**0.53**	**-**

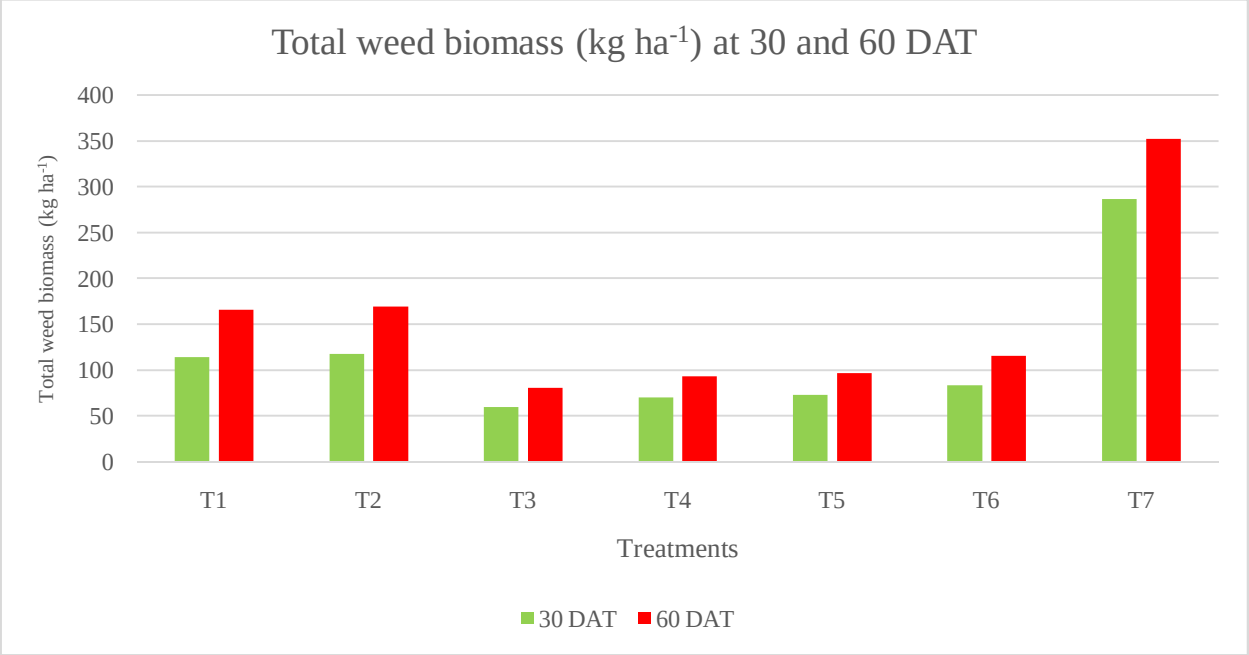

Fig. 1. Effect of integrated weed management practices on total weed biomass (kg ha^{-1}) at 30 and 60 DAT

Conclusion

Based on the experiment results, it concluded that pre-emergence application with conoweeding of Penoxsulam + Butachlor @ 2L/ha (PE) on 3 DAT fb, Conoweeder twice on 25 and 35 DAT (T_3) in rice is the most effective weed control method for obtaining a lower total weed count, weed biomass and higher weed control index.

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