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Influence of various weed management practices on weed dynamics of transplanted rice

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Abstract
The field investigation was carried out at the Experimental Farm, Department of Agronomy, Annamalai University to enumerate the weed management practices for increasing the yield of transplanted rice during the Kuruvai season (June – September, 2023) in a randomized block design with seven treatments and three replications by using the rice variety ADT 43. Among the various treatments, Pretilachlor + Pyrazosulfuron-ethyl @ 615 g a.i ha^{-1} at 3 DAT followed by Fenoxaprop-p-ethyl @ 0.1 kg a.i ha^{-1} at 25 DAT (T_6) which helps in decreasing different weed population and diminishing the weed biomass which increases the yield of transplanted rice. It also recorded the higher weed control efficiency (WCE), weed control index (WCI) and crop resistance index (CRI).

Keywords: Weeds, population, pretilachlor, fenoxaprop-p-ethyl, WCE, CRI

Introduction

Almost half of the world's population, especially in Asia and Africa, depends on rice (*Oryza sativa* L.), a cereal grain, as their primary source of nutrition. The largest rice exporter in the world, India is also the second-largest producer of rice worldwide. The world's total rice area is 165.69 million hectare and production are about 520.87 million metric tonnes with a productivity of 4.70 t ha^{-1} (USDA, 2024) [21]. In India, rice is grown in an area of 47.60 million hectare, having an annual production of 137 million metric tonnes with a productivity of 4.32 t ha^{-1}. In Tamil Nadu, rice is cultivated in an area of 2.03 million hectare with a production of 6.88 million tonnes and productivity of 3380 kg ha^{-1} (Directorate of Economics and Statistics, 2021) [6]. Under lowland ecosystems, transplanted rice is especially afflicted by several forms of weed flora, which can reduce yield by up to 48% and result in an annual loss of 15 million tonnes due to weed competition. For rice cultivation to be successful, weed competition must be avoided and a weed-free environment must be provided during the vital rice growing time (Murali and Gowthami, 2017) [17]. There is a need to integrate with other weed management strategies along with chemical control (Chahal and Jhala, 2015) [4]. Due of their broad range and long-lasting weed control, herbicides have been found to produce significantly better weed control and higher grain yields when used in conjunction with other weed control techniques like physical, cultural, and biological strategies. A single application of one herbicide is not effective against complex weed flora during critical periods of crop weed competition (Duary *et al.*, 2015) [7]. Besides, some of the grass weeds, broad leaved weeds, and sedges are not effectively controlled by the application of a single herbicide. Therefore, sequential application of pre- and post-emergence herbicides may prove promising in the control of all categories of weeds during critical periods in transplanted rice (Dhanapal *et al.*, 2018) [5].

Materials and Methods

The field experiment was conducted in 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. The experiment was laid out in a randomized block design, having seven treatments and replicated thrice to study the effect of different weed management practices on weed indices of transplanted rice.

The treatments were Unweeded control (T_1), Hand weeding twice at 20 DAT and 40 DAT (T_2), Azolla inoculation @ 4.5 kg ha^{-1} at 15 DAT (T_3), Pretilachlor + Pyrazosulfuron-ethyl @ 615 g a.i ha^{-1} at 3 DAT followed by Azolla inoculation @ 4.5 kg ha^{-1} at 15 DAT (T_4), Pretilachlor + Pyrazosulfuron-ethyl @ 615 g a.i ha^{-1} at 3 DAT followed by one hand weeding at 40 DAT (T_5), Pretilachlor + Pyrazosulfuron-ethyl @ 615 g a.i ha^{-1} at 3 DAT followed by Fenoxaprop-p-ethyl @ 0.1 kg a.i ha^{-1} at 25 DAT (T_6), Fenoxaprop-p-ethyl @ 0.1 kg a.i ha^{-1} at 25 DAT followed by one hand weeding at 40 DAT (T_7). For this experiment, the rice variety ADT 43 was chosen and it was transplanted at a 15 × 10 cm spacing.

Studies on Weeds

Weed count: Weed counts were recorded at 30 days after transplanting (DAT) and 60 DAT. The counts were taken from four quadrants, each with a fixed size of 0.5 m x 0.5 m in each plot. The average weed count in a quadrant, covering an area of 0.25 m^2, was calculated. The data were then used to determine the weed count in m^2.

Weed dry matter production

The weeds in the sample quadrants were collected at 30 and 60 DAT and oven dried at 80 °C ± 5 °C for 48 hours after removing the roots and the DMP was recorded in kg ha^{-1} in rice crop.

Weed Indices

Weed Control Efficiency (WCE)

Weed control efficiency was worked out to evaluate the comparative efficacy of various herbicide treatments tested for weed control efficiency for each treatment plot and was estimated by using the formula suggested by Mishra and Tosh (1979) [14] and recorded in percentage.

$$WCI = \frac{a - b}{a} \times 100$$

Where,
a = Total weed population (m^{-2}) in unweeded control plot.
b = Total weed population (m^{-2}) in treatment plot.

Weed Control Index (WCI)

Weed control index of each treatment plot was calculated by using the following formula suggested by Mishra and Tosh (1979) [14] and recorded in percentage.

$$WCE = \frac{a - b}{a} \times 100$$

Where,
a = Weed biomass (kg ha^{-1}) in unweeded control plot.
b = Weed biomass (kg ha^{-1}) in treatment plot.

Crop Resistance Index (CRI)

The crop resistance index of each weed management practices was computed using the following formula was suggested by Mishra and Misra (1997) [15].

$$CRI = \frac{\text{Crop dry weight in treated plot}}{\text{Crop dry weight in control plot}} \times \frac{\text{Weed dry weight in control plot}}{\text{weed dry weight in treated plot}}$$

Results and Discussion

The weed flora in the experimental field comprised of weed species *Echinochloa colonum*, *Leptochloa chinensis*, *Cyperus rotundus*, *Cyperus difformis*, *Bergia capensis*, *Eclipta prostrata* and *Sphenoclea zeylanica*. Similar weed flora under transplanted rice condition was also observed by Liu *et al.* (2021) [10], Wang *et al.* (2022) [22], Arthanari (2023) [1] and Kokilam *et al.* (2023) [9].

The study found that weed control treatments significantly impacted individual weed count, total weed count, and weed DMP. Among the weed management practices, Pretilachlor + Pyrazosulfuron-ethyl @ 615 g a.i. ha^{-1} at 3 DAT followed by Fenoxaprop-p-ethyl @ 0.1 kg a.i. ha^{-1} at 25 DAT (T_6) recorded the less weed count and less weed DMP on 30 and 60 DAT. This might be due to mode of action of pretilachlor which inhibits the synthesis of fatty acids in target plants, preventing growth inhibition and ultimately weed death. Pyrazosulfuron-ethyl, an acetolactate synthase (ALS) inhibitor herbicide, effectively managed sedges and broad-leaved weeds by inhibiting the production of essential amino acids, disrupting weed growth and development. The application of post-emergence herbicide fenoxaprop-p-ethyl effectively controlled weed population and biomass in the flowering stage by inhibiting the synthesis of fatty acids in grassy weeds' meristem tissues. This herbicide is effective in inhibiting acetyl CoA carboxylase (ACCase) activity, which is crucial for inhibiting beta oxidation or lipid biosynthesis. Overall, these weed control treatments effectively controlled weed growth and development. The result coincides with the findings of Mondal *et al.* (2019) [16], Ramesha *et al.* (2019) [19], Malemnganbi and Lhungdim (2019) [12], Tahir *et al.* (2021) [20] and Masum *et al.* (2022) [13].

The study reveals that different weed control treatments significantly reduced total weed count (11.75 and 14.30 m^{-2} on 30 and 60 DAT, respectively) and weed dry weight (24.68 and 44.33 kg ha^{-1} on 30 and 60 DAT, respectively), leading to higher weed control efficiency and a better utilization of resources by crop plants. The higher weed control efficiency (86.12%) and weed control index (88.37%) are noticed in the treatment with Pretilachlor + Pyrazosulfuron-ethyl @ 615 g a.i. ha^{-1} at 3 DAT followed by Fenoxaprop-p-ethyl @ 0.1 kg a.i. ha^{-1} at 25 DAT (T_6). The inhibition of weed growth and germination following pre-emergence application of pretilachlor with Pyrazosulfuron-ethyl and post-emergence application of fenoxaprop-p-ethyl effectively managed the second flush of weeds. Blocking the perennation process and inhibiting further multiplication and growth of weeds, particularly grasses, sedges, and broad-leaved weeds, resulted in a lesser weed population and weed dry matter production. The combined effect on weed dry weight and seed yield may have contributed to excellent weed indices. The result coincides with the findings of Bhat *et al.* (2017) [2], Pramanik *et al.* (2020) [18] and Bindu *et al.* (2023) [3].

The application of pre- and post-emergence herbicides resulted in improved weed suppression during the crucial period of weed competition, which helped with the crop's initial vigour and establishment. This, in turn, led to a higher LAI value. Additionally, the aeration of the soil root zone improved root growth and tillering, which increased pre- and post-flowering photosynthesis. Ultimately, this improved source and sink capacities improved the degree of endosperm filling and the size of the grain husk, which in turn improved endosperm filling. Similar findings of the investigation were reported by Mahajan and Chauhan (2015) [11] and Gupta *et al.* (2023) [8].

Table 1: Effect of different weed management practices on weed dynamics of transplanted rice

Treatments	Total weed count (No.m^{-2})		Weed DMP (kg ha^{-1})		WCE at 60 DAT (%)	WCI at 60 DAT (%)	CRI at 60 DAT	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
	30 DAT	60 DAT	30 DAT	60 DAT					
T_1	8.88 (78.40)	10.08 (103.06)	211.68	381.32	-	-	-	2471	3707
T_2	4.42 (19.07)	4.95 (24.02)	43.86	79.27	76.69	79.28	6.69	5664	8496
T_3	6.03 (35.81)	6.66 (43.81)	93.11	157.72	57.49	58.64	2.79	4058	6087
T_4	4.86 (23.16)	5.37 (28.37)	57.91	99.30	72.47	73.96	4.86	4689	7034
T_5	4.31 (18.10)	4.72 (21.76)	39.82	69.63	78.89	81.74	7.69	5743	8615
T_6	3.50 (11.75)	3.85 (14.30)	24.68	44.33	86.12	88.37	12.69	5985	8978
T_7	4.59 (20.57)	5.05 (25.03)	49.37	85.10	75.71	77.68	5.79	4778	7167
S.Ed	0.09	0.11	1.87	3.23	0.91	0.96	NA	78.69	118.05
C.D (p=0.05)	0.21	0.23	4.09	7.12	1.98	2.11	NA	173.37	260.06

*DAT- days after transplanting; LAI- leaf area index; DMP- dry matter production; WCE- weed control efficiency; WCI- weed control index; CRI- crop resistance index.

*Figures in parenthesis indicate the original value and values are square root transformed values; NA- Not analysed statistically

Conclusion

Based on the results of the present study, it can be concluded that efficient and economic weed control in transplanted rice could be achieved by Pretilachlor + Pyrazosulfuron-ethyl @ 615 g a.i ha^{-1} at 3 DAT followed by Fenoxaprop-p-ethyl @ 0.1 kg a.i ha^{-1} at 25 DAT (T_6). It effectively reduced the infestation of weeds in the experimental field and favoured the crop growth parameters and yield of rice.

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