Environment and Ecology 43 (1) : 72—78, January—March 2025
Article DOI: https://doi.org/10.60151/envec/JKFG4506
ISSN 0970-0420

Explicate the Impact of New-Generation Herbicides against Weed Dynamics in Transplanted Rice of Cauvery Delta Zone

D.E. Keerthi, S. Kandasamy, R. Raman, M. Thiruppathi, K. Dhanasekaran

Received 8 December 2024, Accepted 11 January 2025, Published on 27 January 2025

ABSTRACT

During *kharif* season 2022, a field experiment was conducted in clay loam soil at experimental farm, Department of Agronomy, Annamalai University to evaluate the efficacy of new generation herbicides against different weed flora under transplanted rice. The field experiment was laid out in Randomized Block Design (RBD) with three replications comprising eight treatments viz., T_1 - Unweeded control, T_2 - Twice hand weeding on 20 & 40 DAT, T_3 - Pre-emergence application of Penoxsulam 0.97% + Butachlor 38.7% SE @ 2000 ml ha^{-1} at 3 DAT, T_4 - Pre-emergence application of Pyrazosulfuron ethyl 0.75% + Pretilachlor 30% GR 2000 g ha^{-1} at 3 DAT, T_5 - Early post emergence application of Fenoxaprop-p-Ethyl 9.3% EC @ 875 ml ha^{-1} at 10 DAT, T_6 - Early post emergence application of Metsulfuron methyl 10% + Chlorimuron ethyl 10% WP @ 20 g ha^{-1} at 10 DAT, T_7 - Post emergence application of Bispyribac sodium 10% SC @ 250 ml ha^{-1} at 21 DAT and T_8 - Post emergence application of Triafamone 20% + Ethoxy sulfuron 30% WDG @ 225 g ha^{-1} at 21 DAT. The result indicates that hand weeding twice on 20 and 40 DAT significantly reduced the weed population and their dry weight effectively over other treatments. Among the herbicides, pre-emergence application of Penoxsulam 0.97% + Butachlor 38.7% was efficiently controlled wide rage of weeds and recorded higher values of weed control efficiency, weed control index and grain yield of rice. It was at are par with hand weeding twice on 20 and 40 DAT. Thus, it can be concluded that application of Penoxsulam 0.97% + Butachlor 38.7% as pre-emergence as proved superior over rest of the chemical treatments, with respect to efficient weed control, with enhanced yield in transplanted rice under the labor scarced condition.

Keywords Rice, New-generation herbicides, Penoxsulam+Butachlor, Triafamone+Ethoxy sulfuron.

INTRODUCTION

Rice (*Oryza sativa* L.) is a staple food for more than half of Asia's population and a vital source of calories. Globally, rice is cultivated on 165.67 million

D.E. Keerthi[1]* , S. Kandasamy[2], R. Raman[3], K. Dhanasekaran[5]
[1]PhD Scholar, [2,3,5]Professor

[1,2,3,5]Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Annamalai Nagar 608002, India

[4]M.Thiruppathi
Associate Professor, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar 608002, India

Email: saikeerthi0412@gmail.com
*Corresponding author

hectares, producing 520 million metric tonnes with an average productivity of 4.69 tonnes per hectare. In India, rice covers 47.60 million hectares, generating 137.00 million metric tonnes and achieving a productivity of 4.32 tonnes per hectare (USDA 2024). In Tamil Nadu, rice is grown on 2.03 million hectares, yielding 6.88 million tonnes with a productivity of 3.38 tonnes per hectare (Directorate of Economics and Statistics 2021). As the global population grows, the demand for food grains is expected to increase. To maintain and ensure food security in the country, rice productivity must be improved despite limited resources.

However, various biotic and abiotic stresses pose significant challenges to increasing rice yields. Weed intervention and disturbances in rice fields are major challenges that substantially reduce yields. A primary challenge is the competition from weeds for resources viz., water, nutrients, light and space, making effective weed management essential in crop production. Weed interference alone is estimated to reduce rice yields by around 28% (Patel *et al.* 2023) to 80% (Yadav *et al.* 2018) in transplanted rice eco-systems. The scarcity and hiked cost of labor for hand weeding have led to an increased reliance on herbicides in rice cultivation. Herbicidal weed control is become a crucial tool for weed management due to their timely, effective, economical and practical approach to weed control. The careful selection of herbicides and considering the right time, dose and application methodis essential for managing weeds effectively and boosting crop yields. New generation herbicide are also referred to as low-dose, high-efficacy (LDHE) herbicides, which reduces the rate of use, herbicidal phytotoxicity to crops, lowers the cost of application and cuts the problem of residual build up with high efficiency. Considering these aspects the present experiment was carried out to explicate the effectiveness of different new generation herbicides against diverse weed flora and production potential of low land rice crop.

MATERIALS AND METHODS

Field experiment site

The field experiment was conducted during *kharif* season, 2022 in the wetland block of experimental farm at Field No. - C_1, Faculty of Agriculture, Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu, India, to determine the efficacy of new generation herbicides on weed dynamics. The experimental field was geographically situated at 11º24' N latitude, 79º44' E longitudes and at an altitude of + 5.79 m above the mean sea level and lies in the Cauvery Delta Zone. It characterized by a tropical, humid climate with an average rainfall of 292.1 mm during the growing season. Throughout the farming period, the mean maximum and minimum temperatures were 35.33°C and 24.39°C, respectively, with a relative humidity of 69.82%. The soil in the area was clay loam texture, a pH of 7.2, organic carbon content of 0.44% and nutrient levels classified as low in nitrogen (235.1 kg ha^{-1}), medium in phosphorus (23.3 kg ha^{-1}), and high in potassium (312.4 kg ha^{-1}).

Methodology

The field experiment was laid out in Randomized Block Design (RBD) with three replications. The treatments comprised of T_1 - Unweeded control, T_2- Twice hand weeding on 20 & 40 DAT, T_3 - Pre-emergence application of Penoxsulam 0.97% + Butachlor 38.7% SE @ 2000 ml ha^{-1} at 3 DAT, T_4 - Pre-emergence application of Pyrazosulfuron ethyl 0.75% + Pretilachlor 30% GR 2000 g ha^{-1} at 3 DAT, T_5 - Early post emergence application of Fenoxaprop-p-Ethyl 9.3% EC @ 875 ml ha^{-1} at 10 DAT, T_6 - Early post emergence application of Metsulfuron methyl 10% + Chlorimuron ethyl 10% WP @ 20 g ha^{-1} at 10 DAT, T_7 - Post emergence application of Bispyribac sodium 10% SC @ 250 ml ha^{-1} at 21 DAT, and T_8 - Post emergence application of Triafamone 20%+Ethoxy sulfuron 30 % WDG @ 225 g ha^{-1} at 21 DAT. The ADT 43, short duration rice variety (110 days) was used as test crop and 21 days old seedlings were transplanted at a spacing of 15×10 cm, with 2 seedlings $hill^{-1}$. As per the treatment schedule, formulated herbicides was sprayed using knapsack sprayer fitted with flood jet deflector nozzle using spray fluid of 500 liter ha^{-1} for pre-emergence and for early post emergence and post-emergence application, 375 liter of spray fluid ha^{-1} were used. Urea, single super phosphate and muriate of potash were used as fertilizers, applied at the recommended rate of 150:50:50 NPK kg ha^{-1} in accordance with the crop production guidelines. Irrigation was consistently maintained at a depth of 3–5 cm throughout the cropping season and discontinued 10 days prior to harvest.

Data collection

Observations of weed density and weed dry weight were recorded from sample rows in each plot at 30, 45 and 60 days after transplanting (DAT) using quadrats (0.5 m × 0.5 m). Weed samples were shade dried then oven-dried at 60°C until it reaches constant weight.

Weed control efficiency (WCE)

The effectiveness of weed control (WCE) is determined by comparing the weed population in treated plots to that in untreated (control) plots. The formula by Choudhary *et al.* (2022) used to calculate WCE is as follows

$$\text{WCE} = \frac{\text{WPC} - \text{WPT}}{\text{WPC}} \times 100$$

Where,

WPC = Weed population in the control plot
WPT = Weed population in the treated plot

Weed control index (WCI)

The weed control index (WCI) is calculated based on the reduction in weed dry weight in the treated plot relative to the dry weight reduction in the untreated (control) plot. The following formula is used to calculate WCI as suggested by Choudhary et al. (2022).

$$\text{WCI} = \frac{\text{WC} - \text{WT}}{\text{WC}} \times 100$$

Where,

WC = Dry weight of weeds in the control plot
WT = Dry weight of weeds in the treated plot

Weed index (WI)

The weed index (WI) measures the reduction in crop yield due to weed competition in treated plots relative to a weed-free control. It is calculated using the formula suggested by Yadav et al. (2008).

$$\text{WI} = \frac{\text{YWF} - \text{YT}}{\text{YWF}} \times 100$$

Where,

YWF = Yield of the crop in the weed-free control plot
YT = Yield of the crop in the treated plot

This index represents yield loss as a percentage, reflecting the effectiveness of the weed control treatment in minimizing weed competition.

Grain yield

The crop was harvested from the net plot area, then hand-threshed, winnowed and sun-dried to a moisture content of 14%. The average yield for each treatment was calculated in kg/ha and recorded in tables.

Statistical analysis

According to methodology given by Gomez and Gomez (2010) the statistical analysis of data were done. Prior to statistical analysis, data on individual weed count and biomass were subjected to a square root transformation ($\sqrt{x+0.5}$) to normalize their distribution. The critical difference (CD) at the 5% significance level was used to assess the statistical significance of treatment effects on various parameters.

RESULTS AND DISCUSSION

Weed floristic composition of the experimental field

During the crop growth phase, weed species from three taxonomic groups were identified, including three grass species, three sedge species, and four broad-leaved weed species. Among the grasses, the most prevalent weeds were *Echinochloa colonum*, *Echinochloa crusgalli* and *Leptochloa chinensis*. The

Table 1. Effect of new-generation herbicides on weed density (No. m^{-2}) at 30, 45 and 60 DAT of transplanted rice crop. BLW – Broad leaved weeds.

Treat-ments	Weed density at 30 DAT				Weed density at 45 DAT				Weed density at 60 DAT			
	Grasses	Sedges	BLW	Total	Grasses	Sedges	BLW	Total	Grasses	Sedges	BLW	Total
T_1	5.68	4.69	4.51	8.58	5.86	4.88	4.54	8.82	6.2	5.1	4.66	9.28
	(31.81)	(21.5)	(19.82)	(73.13)	(33.84)	(23.31)	(20.1)	(77.25)	(38.4)	(25.99)	(21.7)	(86.09)
T_2	1.27	1.28	1.32	2	1.26	1.26	1.26	1.93	1.31	1.42	1.47	2.43
	(1.12)	(1.15)	(1.23)	(3.5)	(1.08)	(1.08)	(1.08)	(3.24)	(1.72)	(2.02)	(2.17)	(5.91)
T_3	1.38	1.33	1.38	2.14	1.44	1.38	1.41	2.23	1.37	1.46	1.51	2.51
	(1.4)	(1.28)	(1.41)	(4.09)	(1.56)	(1.41)	(1.49)	(4.46)	(1.88)	(2.12)	(2.28)	(6.28)
T_4	1.47	1.48	1.42	2.32	1.84	1.75	1.78	2.94	3.04	2.63	2.72	4.85
	(1.67)	(1.69)	(1.51)	(4.87)	(2.89)	(2.57)	(2.68)	(8.14)	(9.23)	(6.92)	(7.39)	(23.54)
T_5	2.24	2.88	2.92	4.57	2.92	3.13	2.84	5.04	3.45	3.13	3.33	5.72
	(4.54)	(7.8)	(8.03)	(20.37)	(8.04)	(9.32)	(7.58)	(24.94)	(11.91)	(9.77)	(11.07)	(32.75)
T_6	2.39	2.03	2.16	3.68	2.45	2.18	2.44	3.96	3.14	2.69	2.8	4.99
	(5.22)	(3.64)	(4.18)	(13.04)	(5.48)	(4.26)	(5.45)	(15.19)	(9.83)	(7.21)	(7.85)	(24.89)
T_7	2.52	2.33	2.37	4.05	2.36	2.11	2.24	3.75	1.68	1.70	1.84	3.02
	(5.84)	(4.92)	(5.13)	(15.89)	(5.06)	(3.94)	(4.53)	(13.53)	(2.83)	(2.9)	(3.39)	(9.12)
T_8	2.59	2.24	2.28	4.00	2.28	2.01	2.13	3.57	1.69	1.65	1.75	2.94
	(6.22)	(4.54)	(4.72)	(15.48)	(4.68)	(3.56)	(4.04)	(12.28)	(2.86)	(2.72)	(3.06)	(8.64)
SEd	**0.33**	**0.25**	**0.26**	**0.20**	**0.18**	**0.11**	**0.15**	**0.29**	**0.14**	**0.08**	**0.11**	**0.20**
CD (p= 0.5)	**0.71**	**0.53**	**0.55**	**0.42**	**0.39**	**0.25**	**0.33**	**0.62**	**0.31**	**0.18**	**0.23**	**0.42**

sedges included *Cyperus rotundus*, *Cyperus difformis* and *Fimbristylis littoralis*, while the broad-leaved weeds observed were *Bergia capensis*, *Eclipta alba*, *Marsilea quadrifolia* and *Sphenoclea zeylanica*.

Effect of treatments on weed density and dry weight

All weed control treatments implemented in this study

Table 2. Effect of new-generation herbicides on weed biomass (g m^{-2}) at 30, 45 and 60 DAT of transplanted rice crop. BLW – Broad leaved weeds.

Treat-ments	Weed biomass at 30 DAT				Weed biomass at 45 DAT				Weed biomass at 60 DAT			
	Grasses	Sedges	BLW	Total	Grasses	Sedges	BLW	Total	Grasses	Sedges	BLW	Total
T_1	9.18	8.90	7.00	14.54	9.50	9.10	7.29	15.01	9.68	9.34	7.37	15.34
	(83.75)	(78.73)	(48.50)	(210.98)	(89.83)	(82.33)	(52.70)	(224.86)	(93.70)	(87.30)	(54.30)	(235.3)
T_2	2.32	2.11	1.96	3.56	2.12	1.87	1.59	3.09	2.21	2.20	1.68	3.54
	(4.88)	(3.94)	(3.36)	(12.18)	(4.01)	(3.00)	(2.04)	(9.05)	(4.88)	(4.83)	(2.83)	(12.54)
T_3	2.35	2.15	1.99	3.62	2.28	2.02	1.62	3.31	2.30	2.26	1.80	3.69
	(5.04)	(4.14)	(3.45)	(12.63)	(4.72)	(3.58)	(2.14)	(10.44)	(5.29)	(5.1)	(3.23)	(13.62)
T_4	2.56	2.51	2.37	4.17	2.93	2.53	2.31	4.40	3.50	2.79	2.97	5.37
	(6.03)	(5.80)	(5.1)	(16.93)	(8.11)	(5.92)	(4.83)	(18.86)	(12.27)	(7.77)	(8.81)	(28.85)
T_5	3.42	3.89	3.39	6.11	4.17	4.04	3.44	6.68	4.19	4.00	3.41	6.72
	(11.2)	(14.66)	(10.97)	(36.83)	(16.92)	(15.86)	(11.36)	(44.14)	(17.54)	(15.98)	(11.66)	(45.18)
T_6	3.60	3.19	2.77	5.46	3.69	3.27	2.99	5.68	3.63	3.21	2.99	5.70
	(12.43)	(9.70)	(7.20)	(29.33)	(13.14)	(10.21)	(8.43)	(31.78)	(13.2)	(10.33)	(8.93)	(32.46)
T_7	3.69	3.38	3.07	5.78	3.66	3.22	2.88	5.57	3.04	2.49	2.38	4.60
	(13.1)	(10.93)	(8.93)	(32.96)	(12.92)	(9.86)	(7.78)	(30.56)	(9.26)	(6.21)	(5.66)	(21.13)
T_8	3.72	3.33	2.95	5.71	3.60	3.17	2.83	5.48	3.06	2.43	2.28	4.52
	(13.33)	(10.59)	(8.20)	(32.12)	(12.46)	(9.58)	(7.49)	(29.53)	(9.38)	(5.89)	(5.19)	(20.46)
SEd	**0.35**	**0.23**	**0.14**	**0.15**	**0.21**	**0.22**	**0.24**	**0.38**	**0.12**	**0.16**	**0.13**	**0.17**
CD (p=0.5)	**0.74**	**0.49**	**0.30**	**0.32**	**0.45**	**0.48**	**0.51**	**0.82**	**0.25**	**0.34**	**0.29**	**0.37**

Table 3. Effect of new-generation herbicides on grain yield (kg ha^{-1}) and weed indices of transplanted rice crop. *The values in parenthesis are original values and subjected to square root transformation ($\sqrt{x+0.5}$).

Treat-ments	Grain yield (kg ha^{-1})	Nutrient removal by weeds (kg ha^{-1})			Weed control index (%)*			Weed control efficiency (%)*			Weed index (%)
		N	P	K	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	
T_1	1997	46.3	10.8	40.6	0.00	0.00	0.00	0.00	0.00	0.00	65.26
T_2	5748	12.4	1.8	11	76.1 (94.23)	78.43 (95.98)	76.65 (94.67)	77.36 (95.21)	78.18 (95.81)	74.81 (93.14)	0.00
T_3	5609	13.1	2.1	11.4	75.84 (94.01)	77.56 (95.36)	76.08 (94.21)	76.32 (94.41)	76.1 (94.23)	74.33 (92.7)	2.42
T_4	5078	16.5	3.2	15.1	73.54 (91.98)	73.17 (91.61)	69.5 (87.74)	75.05 (93.34)	71.06 (89.46)	58.47 (72.66)	11.66
T_5	4782	19.7	3.7	17.8	65.3 (82.54)	63.7 (80.37)	63.68 (80.34)	58.14 (72.15)	55.38 (67.72)	51.92 (61.96)	16.81
T_6	4998	17.1	3.3	15.9	68.11 (86.1)	67.92 (85.87)	67.79 (85.72)	65.02 (82.17)	63.68 (80.34)	57.47 (71.09)	13.05
T_7	5271	14.9	2.8	13.5	66.72 (84.38)	68.37 (86.41)	72.56 (91.02)	62.22 (78.27)	65.26 (82.49)	71.01 (89.41)	8.30
T_8	5445	14.6	2.6	12.8	67.03 (84.78)	68.75 (86.87)	72.85 (91.3)	62.61 (78.83)	66.5 (84.10)	71.53 (89.96)	5.27
SE_d	**90.8**	**0.65**	**0.16**	**0.61**	**1.46**	**1.39**	**1.69**	**1.49**	**1.62**	**1.44**	-
CD (p=0.5)	**192.4**	**1.4**	**0.34**	**0.34**	**3.13**	**2.98**	**3.63**	**3.19**	**3.48**	**3.08**	-

significantly reduced the population and biomass of grassy weeds, sedges, and broadleaf weeds, as well as total weed count and dry weight at 30, 45, and 60 DAT compared to the unweeded control (Tables 1– 2). The varying effects of herbicides, influenced by their dosage and timing of application, resulted in substantial variability in weed flora across the treatments. The highest weed population was observed in the unweeded control, followed by the Fenoxaprop-p-Ethyl. At 30 DAT, Fenoxaprop-p-Ethyl effective in controlling grasses but not in later stages, likewise not effective against sedges and broad leaved. However hand weeding twice on 20 and 40 DAT, significantly recorded least weeds but than rest treatment but it prove more effective early post emergence application of Fenoxaprop – p - Ethyland unweeded control.

Among the herbicides, at 30 DAT application of Penoxsulam+Butachlor @ 2000 ml ha^{-1} recorded lowest weeds followed by Pretilachlor + Pyrazosulfuron-ethyl but at later stages of the crop (45 and 60 DAT) efficiency of weed control was higher with post emergence application of Pyrazosulfuron-ethyl. The weed menace was minimum under hand weeding done at 20 and 40 DAT, but it was marginal at 60 DAT due to emergence of weeds during later part of crop. The pre-emergence application of redimix herbicide Penoxsulam+Butachlor has selective systemic absorption by leaves and secondary absorption by roots and act as a seed germination inhibitor by virtue of interfering with protein synthesis and proteinase activity, which block the chained amino acids on weedy plants and inhibit weed growth. Similar results was found by Premnath *et al.* (2024). The suppression of late weed flushes increased the effectiveness of post emergence application of Triafamone + Ethoxy sulfuron (T_8) and Bispyribac sodium (T_7) herbicides inhibit weed growth by blocking the enzyme acetolactate synthase (ALS), which is crucial for amino acid production. Amino acids are the building blocks of proteins, so when ALS is inhibited, the weeds cannot produce proteins and ultimately die. The highest weed density and biomass at 30, 45 and 60 DAT were noticed in unweeded control (T_1), due to vigour's growth and utilization of resources consequently expressed its full potential of weeds and produced higher biomass.

Weed control efficiency and weed control index

The improved WCE and WCI were attributed to

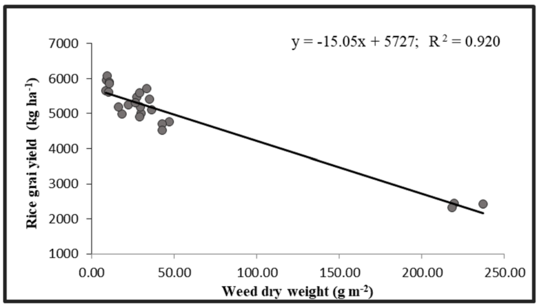

Fig. 1. Relationship between grain yield and weed dry weight of transplanted rice.

reduced weed biomass resulting from effective weed management practices. The data on weed control efficiency (WCE) and weed control index (WCI), recorded at 30, 45 and 60 DAT, are presented in Table 3.

Adoption of two hand weedings at 20 and 40 DAT (T_2) proved highly effective in controlling weeds by achieving maximum, WCE of 95.21, 95.81 and 93.14% at 30, 45 and 60 DAT, respectively. Additionally, WCI was higher in T_2 across these stages and was comparable to the pre-emergence application of Penoxsulam+Butachlor @ 2000 ml ha^{-1} herbicides at the corresponding stages. Among the herbicide treatments, the highest Weed Control Efficiency (WCE) of 94.41, 94.23 and 92.70% at 30, 45 and 60 DAT, respectively, were observed in treatment T_3 (Penoxsulam + Butachlor). The data on Weed Control Index (WCI) at 30, 45 and 60 DAT, was also higher with the T_3 (Penoxsulam+Butachlor) with a highest WCI values of 94.01, 95.36 and 94.21%, respectively. The superior performance of hand weeding, which effectively removed all weeds and vegetation without leaving any weed group or species, resulted in a lower overall weed count and weed dry matter production (DMP), thereby achieving higher WCI values Tomar *et al.* (2019).

Grain yield, nutrient removal by weeds and weed index

The grain yield (kg ha^{-1}) and weed index (%) were significantly influenced by weed management practices, as presented in Table 3. Among these practices, highest grain yield (5748 kg ha^{-1}) were observed with two manual weedings done on 20 and 40 days after transplanting (DAT). The use of herbicides (Penoxsulam+Butachlor) resulted in significantly higher grain yield (5609 kg ha^{-1}) when weed control measures were applied at 3 DAT and on par with T_2. This increase was due to minimized crop-weed competition during critical growth stages, effectively controlling predominant weeds throughout the crop's growth period as evident by registering weed index in T_3, Penoxsulam+Butachlor. The highest weed index (65.26%) was observed under the unweeded control. Similar findings were reported by Patel *et al.* (2023), attributing this to the effectiveness of manual weeding, which ensured the removal of all weeds, including bulbs and tubers. Similarly, new-generation herbicides applied at higher doses demonstrated superior weed control, likely due to their prolonged persistence in the soil. Table 3 represents the calculated data on NPK removal by weeds. All treatments had a considerable impact on the weeds' potential to nutrients depletion. It was found that among the chemical treatments (T_3), Penoxsulam 0.97% + Butachlor 38.7% SE @ 2000 ml ha^{-1} at 3 DAT, removed 13.1, 2.1 and 11.4 kg/ha of nitrogen, phosphorus and potassium from weeds, respectively. Weeds remove more nitrogen, phosphorus and potassium from the soil at rates of 46.3, 10.3 and 40.6 kg/ha, respectively. Weeds' rapid growth may have contributed to their increased nutritional depletion in unweeded regions by allowing them to absorb available nutrients prior to crop plants, which resulted in an inadequate supply of nutrients for the crop.

Grain yield of transplanted rice and weed biomass at critical stage showed negative linear relationship with the co-efficient of determination of 0.920 (Fig. 1). Hence, the current study implies the interference of weed contribute to the negative influence on production potential of rice crop, which ultimately reduces the grain yield of rice crop. Similar findings were reported by Bhargavi *et al.* (2023).

CONCLUSION

It was concluded that based on field experiment, the hand weeding twice on 20 and 40 DAT had significantly resulted higher grain yield, weed control efficiency and weed control index which was statistically significant with all herbicide treatments and lower in the weedy plot. Pre-emergence application of Penoxsulam 0.97% + Butachlor 38.7% SE @ 2000 ml ha^{-1} at 3 DAT resulted in lower weed density, weed dry weight, and weed index and the maximum weed control efficiency and higher grain yield. Hence, Penoxsulam 0.97% + Butachlor 38.7% SE @ 2000 ml ha^{-1} at 3 DAT, was the best choice for chemical weed control in transplanted rice.

REFERENCES

Bhargavi G, Sundari A, Kalaisudarson S, Usharani G (2023) Effect of pre-emergence herbicides on weed dynamics and production potential of rice (*Oryza sativa*) under SRI. *Journal of Applied Biology & Biotechnology* 12 (1) : 1—6. DOI:10.7324/JABB.2023.148386

Choudhary VK, Naidu D, Dixit A (2022) Weed prevalence and productivity of transplanted rice influences by varieties, weed management regimes and row spacing. *Archives of Agronomy and Soil Science* 68 : 1872—1889.

Directorate of economic and statistics (2021) Agricultural statistics for 2020-2021 agricultural crop year at a glance, ministry of agriculture.

Gomez KA, Gomez AA(2010) Statistical Procedure for Agricultural Research. 2nd edn. John Willey and Sons, New York, pp 680.

Patel SK, Chattopadhayaya N, Dubey DV, Namdeo B (2023) Weed control by new generation herbicide and its influence on yield and nutrient uptake in transplanted rice. *International Journal of Plant & Soil Science* 35(21) : 994—1002.

Premnath K, Suseendran K, Kalaiyarasan C, Jawahar S (2024) "Effect of integrated weed management practices in rice (*Oryza sativa*) under SRI". *Journal of Scientific Research and Reports* 30 (10) : 22—27.

Tomar SS, Naresh RK, Chauhan SVS, Yadav A (2019) Effect of herbicides combination forss control of different weed flora in transplanted rice (*Oryza sativa* L.). *Journal of Pharmacognosy and Phytochemistry* 8 (6) : 786—789.

USDA (2024) India grain and feed update (quarterly update May). Global agricultural information network, United State, Depart Agric. Foreign agricultural, Service.

Yadav DB, Singh S, Yadav A (2008) Evaluation of azimsulfuron and metsulfuron-methyl alone and in combination for weed control in transplanted rice. *Indian Journal of Weed Science* 40 (1 & 2) : 16—20.

Yadav DB, Yadav A, Punia SS, Singh N, Duhab A (2018) Pretilachlor+Pyrazosulfuron-ethyl (ready mix) against complex weed flora in transplanted rice and its residual effects. *Indian Journal of Weed Science* 50 : 257—261.