Journal of Scientific Research and Reports

Volume 30, Issue 12, Page 298-306, 2024; Article no.JSRR.126751
ISSN: 2320-0227

Impact of Low-dose Herbicides on Weed Dynamics and Nutrient Removal by weeds in Transplanted Rice

R. Ganesh Kumar [a++], N. Ramesh [a#*], A. Sundari [a†] and N. Senthil Kumar [b‡]

[a] Department of Agronomy, Faculty of Agriculture, Annamalai University, Chidambaram - 608002, Tamil Nadu, India.
[b] Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Chidambaram - 608002, Tamil Nadu, India

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jsrr/2024/v30i122674

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:
https://www.sdiarticle5.com/review-history/126751

Original Research Article

Received: 02/10/2024
Accepted: 04/12/2024
Published: 11/12/2024

ABSTRACT

The objective of this study is to find out the effect of low-dose herbicides on growth and yield in transplanted rice. A field experiment was conducted during the *Kuruvai* season (June – September 2023) at Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India. The experiment was laid out in a

---

[++] PG Scholar;
[#] Associate Professor;
[†] Professor and Head;
[‡] Professor;
**Corresponding author: E-mail: rameshpraneel@gmail.com;*

***Cite as:** Kumar, R. Ganesh, N. Ramesh, A. Sundari, and N. Senthil Kumar. 2024. "Impact of Low-Dose Herbicides on Weed Dynamics and Nutrient Removal by Weeds in Transplanted Rice". Journal of Scientific Research and Reports 30 (12):298-306. https://doi.org/10.9734/jsrr/2024/v30i122674.*

randomized block design with nine treatments and three replications. The treatments consisted of T_1 - unweeded control, T_2 - Twice hand weeding @ 20 and 40 DAT, T_3 - PE application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT alone, T_4 - PE application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT alone + One hand weeding at 30 DAT, T_5 - PE application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT alone, T_6 - PE application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + One hand weeding at 30 DAT, T_7 - PoE application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT alone, T_8 - PE application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT + PoE application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT, T_9 - PE application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + PoE application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT. Among these treatments, it is observed that the pre-emergence application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + Post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT (T_9) had effectively decreased total weed count, weed dry matter production and nutrient removal by weeds. This led to an improvement in crop development and production.

Keywords: Rice; weed; yield; pre and post-emergence herbicides.

1. INTRODUCTION

"Rice plays a very important role in Indian food production and consumption. India is the world's second-largest producer, and consumer of rice after China and the largest exporter of rice in the world. The world's total rice area is 165.67 million hectares and production is about 520 million metric tonnes with a productivity of 4.69 metric tonnes. The productivity of rice in South East Asia is 4.41 metric tonnes" (USDA, 2023). "In India, rice is grown in an area of 47.60 million hectares, having an annual production of 137 million metric tonnes with a productivity of 4.32 tonnes per hectare. In Tamil Nadu, rice is cultivated in an area of 2.03 million hectares with a production of 6.88 million tonnes and productivity of 3.6 tonnes per hectare" (Directorate of Economics and Statistics, 2023). Therefore, novel technologies are required to increase rice productivity.

"For more than half of the world's population, rice, which is farmed in a variety of climatic zones, is the most significant cereal crop. In irrigated low-land rice, transplanting is the most common and traditional technique of establishment. Due to a lack of labour and water, less rice is being transplanted globally. Therefore, to boost rice output, it is necessary to look for alternative crop establishment techniques" (Chhetri et al. 2022; Joseph et al. 2023).

"The transplanted rice ecosystem has a resource-rich environment, the vigorous growth of weeds has also been noticed in the fields and the weeds are identified as the major biological constraints that hinder the attainment of optimal rice productivity in major rice-producing countries of South Asia, such as India" (Rao et al., 2015). A single application of one herbicide is not effective against complex weed flora during critical periods of crop weed competition. Besides, some of the grass weeds, broad leaf weeds and sedges are not effectively controlled by the application of a single herbicide.

"The sequential application of two or more herbicides having greater activity on diverse weed flora due to differential modes of action has become popular in recent years" (Dhanapal et al., 2018). "Therefore, the application of pre and post-emergence herbicides may prove promising in the control of all categories of weeds during critical periods in transplanted rice. The recent trend of herbicide use is to find out an effective weed control measure by using low-dose high-efficiency herbicides, which will not only reduce the total volume of herbicide per unit area, but also be easier for application and be economical to the farmers" (Tripathy et al., 2017). Furthermore, the identification of suitable herbicide combinations is also crucial for the suppression of weeds under different weed management practices in transplanted rice.

2. MATERIALS AND METHODS

The field experiment was conducted in the wetland at the Annamalai University Experimental Farm, Department of Agronomy, Annamalai Nagar. An altitude of +5.79 m above the mean sea level and a distance of 10 km from the Bay of Bengal Sea, the experimental farm is located at 11024' N latitude and 79044' E longitude. The rainfall received during the cropping period was 387.6 mm in 21 rainy days. The maximum temperature recorded during the cropping season ranged from 31.3^{0}C to 40.1^{0}C with a mean of 35.71^{0}C. The maximum temperature recorded during the cropping season ranged from 21.5^{0}C to 25.7^{0}C with a mean of 23.3^{0}C. The relative humidity was recorded from 96 to 77 per cent with a mean of 83.55 per cent. The experimental field soil had a pH of 7.0 and was composed of clay loam. The soil was high in potassium, medium in available phosphate and low in available nitrogen. The experiment employed a randomised block design with three replications and nine treatments.

There were seven treatments, *viz*., T_1 - unweeded control, T_2 - Twice hand weeding @ 20 and 40 DAT, T_3 - PE application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT alone, T_4 - PE application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT alone + One hand weeding at 30 DAT, T_5 - PE application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT alone, T_6 - PE application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + One hand weeding at 30 DAT, T_7 - PoE application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT alone, T_8 - PE application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT + PoE application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT, T_9 - PE application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + PoE application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT. The seeds were treated with Pseudomonas fluorescens at a dosage of 10 g kg^{-1} per seed and Azospirillum at a dosage of 600 g ha^{-1} per seed for the purpose of nursery cultivation. The prescribed amount of pre and post-emergence herbicides was sprayed according to the treatment schedule. All herbicides targeting pre-emergence and post-emergence were applied on 3 days after transplantation (DAT) and 21 DAT, respectively, with sufficient soil moisture. To get a reliable conclusion, the weed count data underwent the standard procedures proposed by Gomez and Gomez (1984) prior to statistical analysis.

3. RESULTS AND DISCUSSION

3.1 Weed Flora

The weed flora in the experimental plots encompassed eight weed species *víz*., *Echinochloa colonum, Echinochloa crus-galli, Leptochloa chinensis, Cyperus rotundus, Cyperus iria, Bergia capensis*, *Eclipta alba and Ammania baccifera*. However, among the weed species, *Cyperus rotundus, Echinochloa colonum* and *Echinochloa crus-galli* were occurring more in number and contributed largely for the total weed population. These were significantly altered by the treatmental effects. The weeds like, *Leptochloa chinensis, Cyperus iria, Bergia capensis*, *Eclipta alba and Ammania baccifera* were also occurred and contributed for the total population. Similar weed flora under transplanted rice condition was also observed by Prasath et al. (2022) and Murali arthanari (2023).

3.2 Weed Density

"The result of the study showed that pre-emergence application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT (T_9) markedly reduced the total weed population. Metsulfuron-methyl + chlorimuron-ethyl is a systemic broad-spectrum herbicide and can be used as pre and post-emergence herbicide, it has been absorbed by foliage and roots and moves throughout the plant, ensuring effective control of weeds. these herbicides target a specific enzyme called ALS (Acetolactate Synthase). ALS is crucial for the production of branched-chain amino acids (BCAAs), BCAAs are vital for plant growth and survival, fulfilling roles in protein synthesis, energy production, stress tolerance, nitrogen management, and secondary metabolite production. Their disruption by herbicides like metsulfuron-methyl and chlorimuron-ethyl has devastating consequences for plant development, ultimately leading to the death of plants". These findings are in line with the studies of (Mahbub et al., 2017).

Fenoxaprop-p-ethyl is a selective post-emergence herbicide that controls annual and perennial grasses in rice. It is most effective when applied to actively growing grasses after they have emerged from the soil and once herbicide is absorbed by the plant, it moves throughout the plant's system, reaching the growing points and ensuring effective control of weeds. Fenoxaprop-p-ethyl is effective as an early post-emergent herbicide, applied when plants are in the 3–5 leaf stage. It's also safe for crops at recommended dosages. The reason behind such reduction in the density of weeds through the application of fenoxaprop-p-ethyl works by inhibiting the Acetyl-CoA Carboxylase (ACCase) enzyme. ACCase is a vital enzyme involved in the first step of fatty acid biosynthesis in plants. By inhibiting ACCase, fenoxaprop-p-ethyl disrupts fatty acid synthesis, leading to the effects of membrane disruption which is the lack of fatty acids disrupts the formation and maintenance of cell membranes, death and also leads to the effect of growth Inhibition leading to stunted growth and eventual plant death. the effectiveness of fenoxaprop-p-ethyl against grasses and noticed reduction of annual grasses by the application of fenoxaprop-p-ethyl in rice (Sekhar et al., 2020) and (Sanjeev kumar et al., 2022).

3.3 Weed Biomass

"Among the herbicide treatments, pre-emergence application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT recorded the least total weed DMP of 7.04 and 9.29 kg ha^{-1} at 30 and 60 DAT, respectively. The lower weed DMP of 17.26 and 25.45 Kg ha^{-1} at 30 and 60 DAT, respectively was noticed in treatment (T_1) unweeded control. The treatment (T_9) performed superior to the others by registering a lower total weed population, and weed dry weight. This might be due to the fact that the better placement of herbicide on the inter-row spacing provided and the better efficacy of herbicide in controlling the emerging weeds led to the suppression of weeds from the beginning". This was in accordance with the findings of (Dey et al., 2020).

The unweeded control plot registered the highest total weed count and maximum DMP at 30 and 60 DAT, respectively. This might be due to the continuous growth of weeds throughout the period of crop cultivation which increased the population of the weeds and due to the uninterrupted growth of weeds during the critical period of crop-weed competition. This was in accordance with the findings of (Bhagavathi et al., 2020) and (Ramesha et al., 2019).

3.4 Nutrient Removal by Weeds

"The loss of nutrients by weeds varied with the intensity of weeds and the type of weed species. The nutrient removal by weeds was maximum under unweeded control due to higher weed count and weed DMP accumulation. Due to high weed competition, nutrients absorbed by weeds are more than crops" (Sivakumar et al., 2020).

The pre-emergence application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT (T_9) registered least nutrient removal by weeds in both the experiments. This might be due to the synergistic and cumulative effect of application of pre-emergence and post-emergence herbicides. Crop plus weeds from a non-weeded area will absorb about the same amount of N as that of the crop from weed-free plot. Thus, the weeds deprive the nutrients that would have normally been available to the rice crop. As the nutrient removal is increased by weeds on account of a higher weed population, adverse effects could be expected on the crop. When the weed growth is effectively checked through herbicides, a reduction in nutrient removal by weeds and an increased weed control index are natural consequences. The effective control of weeds by the application of pre-emergence application of metsulfuron-methyl + chlorimuron-ethyl and post-emergence application of fenoxaprop-p-ethyl led to the least removal of N, P and K by weeds on 60 DAT. The findings are in agreement with (Dey et al., 2020).

Table 1. Weed flora of the experimental field

S.No.	Botanical Name	Common Name	Life form	Family
I	**Grasses**			
1.	*Echinochloa crus-galli* (L.) P. Beauv	Barnyard grass	Annual	Poaceae
2.	*Echinochloa colonum* (L) Link	Jungle grass	Annual	Poaceae
3.	*Leptochloa chinensis* (L.) Nees	Red sprangle grass	Annual	Poaceae
II	**Sedges**			
1.	*Cyperus rotundus* (L.)	Purple nut sedge	Perennial	Cyperaceae
2.	*Cyperus iria* (L.)	Umberlla plant	Annual	Cyperaceae
III	**Broad-leaved weeds**			
1.	*Eclipta alba* (L.) Hassak	False daisy	Annual	Asteraceae
2.	*Bergia capensis* (E.)	Transplanted weed	Annual	Elatinaceae
3.	*Ammannia baccifera* (L.)	Blistering ammania	Annual	Lythraceae

Table 2. Efficacy of low dose herbicides on total weed count (No.m^{-2}) on 30 and 60 DAT in transplanted rice

Treatments	30 DAT	60 DAT
T_1 - Unweeded control	10.15 (102.63)	12.48 (155.41)
T_2 - Twice Hand weeding on 20 DAT and 40 DAT	4.37 (18.61)	5.15 (26.11)
T_3 - Pre-emergence application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT	5.36 (28.23)	6.19 (37.89)
T_4 - Pre-emergence application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT + One Handweeding on 30 DAT	4.77 (22.43)	5.51 (29.95)
T_5 - Pre-emergence application of Metsulfuron-methyl 10%+ Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT	4.99 (24.44)	5.84 (33.65)
T_6 - Pre-emergence application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + One Handweeding on 30 DAT	4.67 (21.39)	5.44 (29.13)
T_7 - Post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT	5.69 (31.92)	6.54 (42.40)
T_8 - Pre-emergence application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT + Post- emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT	3.95 (15.15)	4.81 (22.67)
T_9 - Pre-emergence application of Metsulfuron-methyl 10%+ Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + Post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT	3.53 (12.02)	4.33 (18.33)
S.Ed	0.10	0.12
CD (P=0.05)	0.21	0.25

(Figures in parenthesis indicate the original value)
(Data are subjected to square root transformation)

Table 3. Efficacy of low dose herbicides on weed dry matter production on 30 and 60 DAT (kg ha^{-1}) in transplanted rice

Treatments	30 DAT	60 DAT
T_1 - Unweeded control	17.26 (297.41)	25.45 (647.49)
T_2 - Twice Hand weeding on 20 DAT and 40 DAT	8.10 (65.27)	10.49 (109.64)
T_3 - Pre-emergence application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT	9.85 (96.57)	12.18 (148.25)
T_4 - Pre-emergence application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT + One Handweeding on 30 DAT	8.82 (77.42)	11.13 (123.56)
T_5 - Pre-emergence application of Metsulfuron- methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT	9.45 (89.52)	11.68 (136.66)
T_6 - Pre-emergence application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + One Handweeding on 30 DAT	8.72 (75.63)	11.00 (120.52)
T_7 - Post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT	10.34 (106.58)	12.69 (160.59)
T_8 - Pre-emergence application of Pretilachlor 50% EC @ 0.75 kg/ha on 3 DAT + Post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT	7.60 (57.34)	9.95 (98.53)
T_9 - Pre-emergence application of Metsulfuron-methyl 10%+ Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + Post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT	7.04 (49.15)	9.29 (85.94)
S.Ed	0.18	0.23
CD (P=0.05)	0.39	0.50

(Figures in parenthesis indicate the original value)
(Data are subjected to square root transformation)

Table 4. Efficacy of low dose herbicides on nutrient removal by weeds (kg ha^{-1}) at 60 DAT in transplanted rice

Treatments	**N (Kg ha^{-1})**	**P_2O_5 (Kg ha^{-1})**	**K_2O (Kg ha^{-1})**
T_1 - Unweeded control	36.32	14.65	26.43
T_2 - Twice Hand weeding on 20 DAT and 40 DAT	14.84	7.87	11.51
T_3 - Pre-emergence application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT	23.92	10.56	18.62
T_4 - Pre-emergence application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT + One Handweeding on 30 DAT	19.10	9.26	15.01
T_5 - Pre-emergence application of Metsulfuron-methyl 10%+ Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT	21.76	9.99	16.87
T_6 - Pre-emergence application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + One Handweeding on 30 DAT	18.56	8.95	15.68
T_7 - Post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT	27.56	12.02	20.72
T_8 -Pre-emergence application of Pretilachlor 50% EC @ 0.75 kg ha^{-1} on 3 DAT + Post- emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT	11.97	6.98	9.93
T_9 - Pre-emergence application of Metsulfuron-methyl + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + Post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT	10.16	6.24	7.86
S.Ed	0.42	0.25	0.35
CD (P=0.05)	0.91	0.54	0.74

"The highest nutrient removal by weeds was recorded under the treatment of unweeded control. This might be due to the fact that the presence of more weed population, which provided the chance for the weeds to occupy large space early and established to removal of more nutrients" (Srinithan et al., 2021).

4. CONCLUSION

Based on the experiment results, it concluded pre-emergence application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 20 g ha^{-1} on 3 DAT + post-emergence application of Fenoxaprop-p-ethyl 6.9% EC @ 60 g ha^{-1} on 21 DAT (T_9) in rice is the most effective weed control method for obtaining a lower total weed count, weed biomass and nutrient removal by weeds.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Bhagavathi, M.S., G. Baradhan, S. Kumar and S. Arivudainambi. 2020. Effect of different crop establishment methods and weed management practices on weeds in rice. Plant archives, 20(2): 6564-6568.

Chhetri, P., Singh, R., Moses, S. C., & Paul, A. (2022). Impact of Different Transplanting Method and Nitrogen Management Practices on Growth and Yield of Rice (Oriza sativa L.) cv. Pusa Basmati-1 in Eastern Uttar Pradesh, India. International Journal of Plant & Soil Science, 34(21), 594–601. https://doi.org/10.9734/ijpss/2022/v34i2131305

Dey R.K, Megha Sana, Subhajit Pal, Ramyajit Mondal and Sukanta Pal. 2020. Effect of post emergence herbicides on weed management in transplanted kharif rice (Oryza sativa L.) and their residuality on soil microorganisms. Current Journal of Applied Science and Technology, 39(27): 88-95.

Dhanapal, G.N., S.K. Bai, M.T. Sanjay, P. Nagarjun and A. Sandeep. 2018. Efficacy of weed management practices in transplanted rice under southern dry zone of Karnataka. Indian Journal of Weed Science, 50(3): 294–297.

Directorate of Economics and Statistics (DES), Government of Tamilnadu, production of major agricultural crops. 2023.

Joseph, A. S., Ravi , M. V., Rao , K. N., Bhat , S. N., Ramesh , Y. M., & Sharanagouda , H. (2023). Residual Effect of Direct Seeded and Transplanted Rice, Nutritional Approaches and Slow Release Nitrogen Sources on the Growth Parameters of Blackgram Crop. International Journal of Environment and Climate Change, 13(7), 442–451. https://doi.org/10.9734/ijecc/2023/v13i71897

Mahbub, M.K.A. Bhuiyan, M.M. MirKabir. 2017. Performance of metsulfuron-methyl 10% + chlorimuron-ethyl 2% WP against annual weed inhibition in transplanted rice. The Saudi Journal of Life Sciences, 25(5): 2415-6221.

Murali arthanari, P. 2023. Weed management with Triafamone herbicide in transplanted rice ecosystem. Emirates Journal of Food and Agriculture, 35(4): 351-356.

Prasath, V.R., S. Ramesh, A. Sundari and M.V. Sriramachandrasekharan. 2022. Herbicide efficiency index, productivity and economic efficiency as influenced by pre and post emergence herbicides in transplanted rice. Journal of Hunan University, 49(8): 1091-1100.

Ramesha, Y.M., S.R. Anand, D. Krishnamurthy and B. Manjunatha. 2019. Weed management effect to increase grain yield in dry direct-seeded rice. Indian Journal of Weed Science, 51(1): 6–9.

Rao, A.N., S.P. Wani, M. Ramesha, and J.K. Ladha. 2015. Weeds and weed management of rice in Karnataka state, india. Weed technology, 29(1): 1-17.

Sanjeev kumar, Manoj kumar Singh and Pratik sanodiya. 2022. Efficacy of doses of fenoxaprop-p-ethyl 69% EC and cyhalofop-butyl 10% EC on weed growth, yield and economics in transplanted rice (Oryza sativa). Indian Journal of Agronomy, 67(1): 89-92.

Sekhar, M. Ameena and Nimmy Jose. 2020. Herbicides and herbicide combinations for management of Leptochloa chinensis in wet-seeded rice. Indian Journal of Weed Science, 52(3): 211–216.

Sivakumar, C., M.P.N. Tamilselvan and A. Krishnaveni. 2020. Chemical and non-chemical weed management effects on weed spectrum, yield and economics of direct- seeded rice in North-Western zone of Tamil Nadu. Indian Journal of Weed Science, 52(4): 309-312.

Srinithan, T., K. Arivukkarasu, P. Sivasakthivelan and R. Immanuel. 2021. Evaluation of early post-emergence herbicide application on weed control, crop growth and nutrient uptake in transplanted rice (*Oryza sativa* L.). Plant Archives, 21(1): 2542-2544.

Tripathy S.K, S. Mohapatra and A.K. Mohanty. 2017. Bio-efficacy of post-emergence herbicides for control of complex weed flora in drum-seeded rice (*Oryza sativa*). Indian Journal of Agronomy, 61 (4): 474-478.

USDA-United States Department of Agriculture, Global Market Analysis-2023.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/126751