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Effect of Low Dose High Efficacy Herbicides on Growth and Yield of Transplanted Rice under Sodic Soil and their Residual Effects on Succeeding Greengram

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ABSTRACT: Rice is a vital food crop, extensively cultivated in India and forming a key part of diets worldwide. It plays a crucial role in global food security, especially in the Asia-Pacific region, where 56% of the population resides, producing and consuming over 90% of the world's rice. Several factors reduce rice productivity, with weed infestation being the primary biotic threat in transplanted rice. Weeds grow faster, dominate the crop environment, and significantly diminish rice yield potential. To address this challenge, a field experiment was conducted during the Samba season (Rabi) to assess various weed management practices in transplanted rice grown in sodic soil and to examine any residual effects on a succeeding green gram crop. The experiment was designed as a randomized block design with three replications, testing the effectiveness of pre-emergence herbicides, early post-emergence herbicides, and post-emergence herbicides combined with hand weeding, alongside an unweeded control. The results revealed that the pre-emergence application of bensulfuron-methyl + pretilachlor at 60 + 600 g a.i. ha^{-1} on 3 DAT, followed by hand weeding at 40 DAT (T_4), produced the highest grain yield and significantly reduced weed dry weight. Importantly, no residual herbicide effects were observed on the succeeding green gram crop.

Keywords: Transplanted rice, Herbicides, weed dry weight, WCE, Residual effects.

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for over 60% of the global population. Rice is indeed a vital staple food crop, especially in tropical regions and particularly in India. The phrase "Rice is Life" highlights its critical role in ensuring food and nutritional security, particularly in Asia, where a large portion of the population depends on it (Basu *et al*., 2021).

India ranks as the second-largest producer of rice globally, with cultivation spanning 43.8 million hectares, yielding 118.4 million tonnes of rice, and achieving a productivity rate of 2.7 tonnes per hectare (GOI, 2021). This underscores the importance of rice in India's agricultural economy and its contribution to feeding millions of people.

To meet the growing demand, it is estimated that an additional 114 million tons of milled rice will be needed by 2035, representing a 26% increase in production over the next 25 years (Kumar and Ladha 2011). Maintaining food self-sufficiency and addressing future needs will require India to boost its rice productivity by 3% annually, though the expansion of rice-growing areas remains limited (Sathya Priya *et al*., 2017). Currently, the average yield of rice in India is hindered by several constraints, with weeds being a major biotic challenge to increasing productivity.

Weeds are a significant threat to rice cultivation worldwide, particularly in transplanted rice systems, where about 60% of weeds emerge between one week and one month after transplanting. These weeds compete with rice during the critical tillering stage, reducing panicle formation and subsequently lowering grain yield (Soe Thura, 2010). In transplanted rice, weeds account for a 45-51% yield reduction (Veeraputhiran and Balasubramanian 2013), as they compete with rice for essential resources like moisture, nutrients, light, temperature, and space. If left unchecked, weeds can reduce rice yields by 33-45% (Manhas *et al*., 2012).

Effective weed control is crucial for maximizing rice production. Currently, herbicides like butachlor, anilofos, oxadiargyl, and pretilachlor are used in transplanted rice to control annual grasses. However, while these herbicides effectively target grasses, they are less effective against annual sedges and broad-leaved weeds. When grasses are well-controlled, sedges and broad-leaved weeds often proliferate, competing with the crop and causing significant yield losses (Singh *et al*., 2004).

On the other hand, rising labor costs discourage farmers from choosing hand weeding, which is no longer economical in the current scenario (Ahmed *et al*., 2021). Instead, herbicide-based weed control is regarded as the most cost-effective solution (Saha *et al*., 2021).The recent trend in weed management emphasizes the use of low-dose, high-efficiency (LDHE) herbicides. These herbicides not only reduce the total volume of chemicals applied but are also easier and more economical to use (Pal and Banerjee 2007). Sulfonylurea herbicides, such as bensulfuron-methyl, metsulfuron-methyl, chlorimuron-ethyl, pyrazosulfuron-ethyl, and bispyribac sodium, are particularly effective at low application rates, making them excellent LDHE options.

Therefore, the current study aims to evaluate different LDHE herbicides as part of an integrated weed management strategy while also focusing on improving yield attributes in transplanted rice.

MATERIALS AND METHODS

Experimental Site and Soil Characteristics. The experiment was conducted during the Samba season (Rabi) of 2016-17 at the Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli. During the cropping season, the total rainfall recorded was 161.1 mm, spread over 12 rainy days. The mean maximum and minimum temperatures were 37.8°C and 20.7°C, respectively. The relative humidity was 52.7% in the forenoon and 73.7% in the afternoon. The site experienced 6.3 hours of bright sunshine per day, with an average evaporation rate of 3.3 mm/day and a wind velocity of 3.8 km/hr.

The soil at the experimental site was alkaline with a pH of 8.8, and had a sandy clay loam texture, classified as *Typic Udic Haplustalf*. It was moderately drained. In terms of nutrient content, the soil was low in available nitrogen (238.3 kg/ha), medium in available phosphorus (17.2 kg/ha), and high in available potassium (303.4 kg/ha).

Experimental design with treatment details. The field experiment was laid out in the completely randomized block design with three replications with ten treatments were T_1- pre-emergence application of pyrazosulfuron ethyl at 25 g *a.i.*ha^{-1} on 3 DAT *fb* hand weeding on 40 DAT, T_2- pre-emergence application of pyrazosulfuron ethyl at 25 g *a.i.* ha^{-1} on 3 DAT *fb* early postemergence application of bispyribac sodium at 25 g *a.i.* ha^{-1} on 8-12 DAT, T_3- pre-emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g *a.i.* ha^{-1} on 3 DAT *fb* hand weeding on 40 DAT, T_4- pre-emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g *a.i.* ha^{-1} on 3 DAT *fb* early postemergence application of bispyribac sodium at 25 g *a.i.* ha^{-1} on 8-12 DAT, T_5- pre-emergence application of pyrazosulfuron ethyl at 25 g *a.i.* ha^{-1} on 3 DAT *fb* post-emergence application of 2,4-D sodium salt at 80 g *a.i.* ha^{-1} on 25-30 DAT, T_6- pre-emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g *a.i.* ha^{-1} on 3 DAT *fb* post-emergence application of 2,4 D sodium salt at 80 g *a.i.*ha^{-1} on 25-30 DAT, T_7- early postemergence application of bispyribac sodium at 25 g *a.i.*ha^{-1} on 8-12 DAT *fb* post-emergence application of 2,4-D sodium salt at 80 g *a.i.*ha^{-1} on 25-30 DAT, T_8- early post-emergence application of oxadiargyl at 80 g *a.i.* ha^{-1} on 8-12 DAT *fb* post-emergence application of 2,4-D sodium salt at 80 g *a.i.* ha^{-1} on 25-30 DAT, T_9- hand weeding twice at 20 *fb* 40 DAT, T_{10}- unweeded check, and replicated thrice.

Cultivar Selection and Biometric Observation. The field experiments were carried out during the Samba season (Rabi) 2016-17 using the medium-duration variety TNAU Rice TRY 3. Biometric observations were recorded during the study, including measurements of plant height, weed dry weight, yield, and leaf area index at the time of panicle initiation. Weed control efficiency and weed index were calculated following standard procedures.

Succeeding Green Gram. After the rice crop was harvested, the succeeding crop of green gram (VBN 2) was grown without altering the original layout of the rice experiment. The green gram was dibbled into rice stubbles, utilizing the residual soil moisture. A seed rate of 20 kg/ha was used, with a spacing of 30 × 10 cm. Germination occurred at 10 days after sowing (DAS), and plant height was measured at 30 DAS.

Statistical Analysis. The data collected from the various treatments were statistically analyzed according to the methods proposed by Gomez and Gomez (1984). Data on weed density and weed dry weight were subjected to square root transformation ($\sqrt{x + 0.5}$) to normalize the distribution. Treatment differences were evaluated at a 5% probability level, with non-significant comparisons indicated as 'NS'.

RESULTS AND DISCUSSION

During the Samba season (Rabi) 2016-17, the experimental field exhibited a diverse weed population comprising grasses, sedges, and broad-leaved weeds. Grasses were the most dominant, followed by sedges and broad-leaved species. The predominant grasses were *Cynodondactylon*, *Echinochloa colona*, and *Panicumrepens*. Among the sedges, *Cyperusdifformis* and *Cyperus rotundus* were common. The prominent broad-leaved weeds observed included *Ammannia baccifera, Ipomoea aquatica*, and *Marsilea quadrifoliata*.

The weed control treatments significantly reduced weed dry weight during the investigation (Table 1). The lowest dry weight of 1.13 g/m² was observed with the pre-emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g *a.i.* ha^{-1} on 3 DAT, followed by hand weeding on 40 DAT. This aligns with the findings of Sureshkumar *et al.* (2016). Similarly, Singh *et al*. (2012) reported that two hand weeding in transplanted rice greatly reduced weed dry weight, which was also confirmed in this study. The enhanced expression of yield-related traits in rice may be attributed to the reduced frequency and growth of weeds, as shown in studies on weed dry matter in herbicide-treated plots. This finding is consistent with the research of Rani *et al.* (2021).

In contrast, Parthipan *et al*. (2013) noted that the highest weed dry matter was recorded in the unweeded check, indicating that without proper weed control, weed dry weight continuously increases, negatively impacting crop growth. This reduction in weed density and dry weight may be attributed to the effective removal of the first and second flushes of weeds, reducing competition for resources. The use of early post-emergence herbicide in combination with one hand weeding also effectively minimized weed biomass.

Higher weed control efficiency (88.1) was recorded with the pre-emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g *a.i.* ha^{-1} on 3 DAT, followed by hand weeding on 40 DAT. Rawat *et al.* (2021) also confirmed the above findings in their research programme.

Growth and Yield of Rice. The highest plant height (102.1 cm) and leaf area index (4.6) were observed in the treatment with pre-emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g *a.i.* ha^{-1} on 3 DAT, followed by hand weeding on 40 DAT (Table 1). The effective weed control in this treatment likely promoted better growth by ensuring more availability of growth resources. Weed control treatments had a significant positive impact on yield attributes compared to the unweeded check. This treatment produced a greater number of grains per panicle and panicles per square meter, likely due to reduced competition for nutrients, space, and light, which led to a higher number of productive tillers per square meter.

Table 1: Effect of LDHE on Weed dry weight, Weed control efficiency, Growth and yield attributes of Transplanted rice under sodic soil.

Treatments	Weed dry weight (gm^{-2})	WCE (%)	Growth attributes		Yield attributes	
			Plant Height (cm)	LAI	Grain yield (kg/ha)	Straw Yield (kg/ha)
T_1- PE PSE *fb* HW on 40 DAT	9.0 (3.08)	70.5	84.2	3.7	4502	6207
T_2- PE PSE *fb* EPOE Bispyribac	8.3 (2.96)	64.8	81.1	3.5	4299	6164
T_3- PE Bensulf + Pretila*fb* HW on 40 DAT	4.2 (2.16)	88.1	102.1	4.6	4987	6841
T_4- PE Bensulf + Pretila*fb* EPOE Bispyribac	6.3 (2.61)	60.7	93.5	3.8	4199	6106
T_5 - PE PSE *fb* POE 2,4-D Na salt	19.5 (4.47)	67.2	88.0	3.6	4088	5834
T_6- PE Bensulf + Pretila*fb* POE 2,4 -D Na salt	5.8 (2.50)	83.2	83.5	3.8	4532	6603
T_7 - EPOE Bispyribac*fb* POE 2,4 -D Na salt	7.3 (2.80)	82.0	85.6	3.4	3435	5808
T_8 -EPOE Oxadiargyl*fb* POE 2,4 -D Na salt	23.4 (4.88)	48.0	79.6	3.2	4046	6046
T_9 -Hand weeding at 20 and 40 DAT	4.5 (2.22)	85.7	91.4	3.9	4405	6443
T_{10} - Unweeded check	33.6 (5.84)	-	77.1	3.3	2943	4383
SE d	0.18	-	4.8	0.28	209	308
CD (P = 0.05)	0.38	-	10	0.6	433	626

( ) - $\sqrt{x + 0.5}$ transformation fb- followed by

Note : PSE- Pyrazosulfuron ethyl ; Bensulf- Bensulfuron methyl; Bispyribac-Bispyribac sodium; Pretila-Pretilachlor; PE- Pre emergence ; EPOE- Early Post Emergence ; POE-Post Emergence ; HW-Hand weeding

The pre-emergence herbicide effectively controlled weeds at an early stage, while supplemental hand weeding managed weed growth at later stages, resulting in superior weed control efficiency. These findings corroborate the results of CharanTeja (2015).

The highest grain yield (4987 kg/ha) and straw yield were recorded in the same treatment. The increase in grain yield by 69.45% in herbicide-treated plots compared to the unweeded check was attributed to several factors, including: (i) reduced crop-weed competition, (ii) improved light transmission for photosynthesis (iii) reduced nutrient depletion by weeds, and (iv) enhanced nutrient uptake by the crop. Similar findings were reported by Abdhullah (2011); Uma *et al*. (2013); Charan Teja (2015); Nivetha *et al.* (2017), who also observed the highest grain yield with pre-emergence application of bensulfuron methyl + pretilachlor. The lower grain yield was recorded with unweeded check.

Succeeding Greengram. The growth and establishment of green gram were not significantly impacted by the herbicide application in rice. No significant differences were observed in terms of germination percentage at 10 DAS or plant height at 30 DAS among the treatments. However, the highest germination percentage (81%) was recorded under the two hand weeding treatment (Table 2), consistent with findings from Upendra Rao *et al.* (2009); Parthipan *et al*. (2013) for succeeding black gram, as well as Ezhilarasi *et al*. (2012) for succeeding green gram. Basu *et al.* (2021) also reported that herbicides used in their research experiments in rice field recorded with no residual effect on succeeding greengram.

Table 2: Influence of herbicide and theirResidual effects on succeeding Green gram.

Treatments	Germination (%)	Plant height (cm)
T_1- PE PSE *fb* HW on 40 DAT	78 (62.03)	24.0
T_2- PE PSE *fb* EPOE Bispyribac	77 (61.34)	24.3
T_3- PE Bensulf + Pretila*fb* HW on 40 DAT	80 (63.44)	25.1
T_4- PE Bensulf + Pretila*fb* EPOE Bispyribac	78 (62.03)	24.1
T_5 - PE PSE *fb* POE 2,4-D Na salt	79 (62.63)	23.5
T_6- PE Bensulf + Pretila*fb* POE 2,4 -D Na salt	78 (62.03)	24.7
T_7 - EPOE Bispyribac*fb* POE 2,4 -D Na salt	78 (62.03)	24.8
T_8 -EPOE Oxadiargyl*fb* POE 2,4 -D Na salt	77 (61.34)	24.6
T_9 -Hand weeding at 20 and 40 DAT	81 (64.16)	24.9
T_{10} - Unweeded check	80 (63.44)	24.0
SE d	0.8	0.8
CD (P = 0.05)	NS	NS

( ) – Ascn transformation fb- followed by

Note : PSE- Pyrazosulfuron ethyl ; Bensulf- Bensulfuron methyl ; Bispyribac-Bispyribac sodium ; Pretila-Pretilachlor ; PE- Pre emergence ; EPOE- Early Post Emergence ; POE-Post Emergence ; HW-Hand weeding

CONCLUSIONS

This investigation concluded that for transplanted rice grown in sodic soils, the pre-emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g *a.i.* ha^{-1} on 3 DAT, followed by hand weeding on 40 DAT, significantly improved growth, straw yield, and yield attributes. This treatment provided broad-spectrum weed control and resulted in higher net returns and a favourable B : C ratio, with performance closely followed by the two hand weeding treatment. Therefore, this herbicide application strategy can be recommended for effective weed control, promoting growth and yield in transplanted rice, with no residual effects on the succeeding green gram.

FUTURE SCOPE

The future scope lies in understanding the delicate balance between optimizing herbicide use for weed control in rice, maintaining soil health, ensuring the success of subsequent crops like greengram, and minimizing environmental impacts. Research focusing on soil microbial activity, residue dynamics, and long-term sustainability will be key in making these herbicides a viable option in sodic soil management systems.

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Conflict of Interest. None.

REFERENCES

Abdhullah, Md (2011). Bio-efficacy of bensulfuron methyl + Pretilachlor 6.6% GR against weedsuppression in transplanted rice. *Bangladesh J. Weed Sci., 2* (1&2), 9-13.

Ahmed, S., Kumar, V., Alam, M., Dewan, M. R., Bhuiyan, K. A., Miajy, A. A., Saha, A., Singh, S., Timsina, J. and Krupnik, T. J. (2021). Integrated weed management in transplanted rice: options for addressing labor constraints and improving farmers'income in Bangladesh. *Weed Technology, 35*(5), 697-709.

Basu, B. J., Prasad, P. V. N., Murthy, V. R. K., Rani, Y. A., & Prasad, P. R. K. (2021). Efficacy of sequential application of herbicides on weed management, rice nutrient uptake and soil nutrient status in dry direct-seeded rice-greengram sequence. *Indian Journal of Weed Science*, *53*(4), 398-404.

Charan Teja, K., Duary, B. and Bhowmik, M. K. (2015). Efficacy of herbicides on weed management in wet season transplanted rice. *Journal of Crop and Weed*, *11*, 224-227.

Ezhilarasi, V., S. Manoharan, P. Murali Arthanari and Chinnusamy, C. (2012). Residual effects of pre emergence mixed herbicides in transplanted rice on succeeding crops. *Proceedings of the Biennial conference on Indian society of weed science on weed threat to Agriculture, Biodiversity and Environment*, April 19-20, 2012, Thrissur, Kerala, India, PP: 58.

GOI (Government of India). 2021. *Economic Survey 2020-21.Statistical Appendix.* Volume 2. Ministry of Finance. Government of India, New Delhi.

Gomez, K.A. and Gomez, A. A. (1984). *Statistical procedure for Agricultural research*, John Wiley and Sons, New York. pp. 680.

Kumar, V., and Ladha, J. K. (2011). Direct- seeding of rice: Recent developments and future research needs. *Advances in Agronomy*, *111,* 297-413.

Manhas, S. S., Govindra Singh, Dhasima Singh, and Khajuna, V. (2012). Effect of tank-mixed herbicides on weeds and transplanted rice (*Oryza sativa* L.) *Annals of Agricultural Research, New Series, 33*(1- 2), 25-31.

Nivetha, C., G. Srinivasan and Shanmugam, P. M. (2017). Effect of Weed Management Practices on Growth and Economics of Transplanted Rice under Sodic Soil. *International Journal of Current Microbiology and Applied Sciences, 6*(12), 1909-1915.

Pal, S. and Banerjee, H. (2007). Efficacy of penoxsulam against weeds in transplanted Kharif rice (*Oryza sativa* L.). *Indian Journal of Weed Science*, *39* (3&4), 172–175.

Parthipan, T., V. Ravi, E. Subramanian and Ramesh, T. (2013). Integrated weed management on growth and yield of transplanted rice and its residual effects on succeeding black gram. *Journal of Agronomy, 12* (2), 99-103.

Rani, V. D., Pinto, B., Kanu, M., and Srijani, M. (2021).Predominant Sedges & Broad-Leaved Weed Management by Herbicides and its Impact on Yield Parameters, Harvest Index and Grain Yield, Straw Yield of *Kharif* Direct Seeded Rice: *Biological Forum– An International Journal, 13*(2), 254-259.

Rawat, A. K., Lodhi, S. R., Tiwari, A. and Nayak, S. (2021). Performance of Herbicides on Weeds andProductivity of Transplanted Rice in Central Part of India. *Biological Forum – An International Journal*, *13*(4), 607-615.

Saha, S., Munda, S., Singh, S., Kumar, V., Jangde, H. K., Mahapatra, A. and Chauhan, B. S. (2021). Crop establishment and weed control options for sustaining dry direct seeded rice production ineastern India. *Agronomy, 11*(2), 389-409.

Sathya Priya, R., Chinnusamy, C., Murali Arthanari, P. and Janaki, P. (2017). Carryover effect and plant injury from oxyfluorfen herbicide applied in transplanted rice. *Internation Journal of Chemical Studies, 5*(3), 535-539.

Singh, A.P., Singh, A. K., Chaturvedi, S. Singh, S., and Mishra, O. P. (2012). Bio-efficacy of Sulphonyl urea herbicides on mixed weed flora in transplanted rice. *Indian Journal of Agriculture Research*, *46,* 9-15.

Singh, G., Singh, V. P. and Singh, M. (2004). Effect of almix and butachlor alone and in combinations on transplanted rice and associated weeds. *Indian J. Weed Sci*., *36*, 64-67.

Soe Thura, 2010. Evaluation of Weed Management practices in the System of Rice Intensification (SRI). *M.Sc. (Ag.) Thesis, Department of Agronomy, Yezin Agricultural University, Yezin, Nay Pyi Taw.*

Sureshkumar, R., Durairaj Nalliah, S., Marimuthu, S. and Muthukumar, M. (2016). Weed characters and indices of transplanted rice as influenced by different weed management practices. *International Journal of Agriculture Sciences, 8*(51), 2221-2223.

Uma, G. and Ramana, M. V. (2014). Evaluation of low dose herbicides in transplanted rice (*Oryza sativa* L.). *International Journal of Applied Biology and Pharmaceutical Technology*, *5* (4), 96-101.

Upendra Rao, R., K.M. Dakshina Murthy and C. Venkata Reddy (2009). Efficacy of bispyribac sodium 10 % SC on early post emergence herbicides on rice. *Proceedings of the National symposium on weed threat to Environment, Biodiversity and Agriculture Productivity*, August 2-3, 2009, Coimabatore, India, PP: 117.

Veeraputhiran, R., and Balasubramanian, R. (2013). Evaluation of bispyribac-sodium in transplanted rice.*Indian Journal of Weed Science, 45*(1), 12-15.

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