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Shiyas V
PG Scholar, Department of
Agronomy, College of Agriculture
Vellayani, Kerala Agricultural
University, Thiruvananthapuram,
Kerala, India

Dr. Renjan B
Associate Professor (Agronomy),
Farming Systems Research
Station, Kerala Agricultural
University, Sadanandapuram,
Kollam, Kerala, India

Dr. Shalini Pillai P
Professor, Department of
Agronomy, College of Agriculture,
Vellayani, Kerala Agricultural
University, Thiruvananthapuram,
Kerala, India

Dr. Bindu B
Associate Professor (Horticulture),
Farming Systems Research
Station, Kerala Agricultural
University, Sadanandapuram,
Kollam, Kerala, India

Dr. Atul Jayapal
Assistant Professor, Department of
Agronomy, College of Agriculture,
Vellayani, Kerala Agricultural
University, Thiruvananthapuram,
Kerala, India

Corresponding Author:

Dr. Renjan B
Associate Professor (Agronomy),
Farming Systems Research
Station, Sadanandapuram, Kerala
Agricultural University, Kollam,
Kerala, India

Effect of land management and weed management in transplanted rice

Shiyas V, Renjan B, Shalini Pillai P, Bindu B and Atul Jayapal

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Abstract

The field experiment was conducted at the State Seed Farm, Kottarakkara during *Rabi* 2024 with an objective to study the effect of land and weed management on growth and yield of transplanted rice. The experiment was laid out in split plot with four replications. The main plot treatments were assigned to three land management practices (I₁: conventional tillage, I₂: farmers' practice and I₃: stale seed bed technique). The sub-plot treatments consisted of six weed management practices: pre-emergence (PE) application of oxyfluorfen at 0.15 kg ha⁻¹, post-emergence (PoE) application of the herbicide penoxsulam + butachlor at 820 g ha⁻¹, application of florypyrauxifen-benzyl at 31.25 g ha⁻¹, metsulfuron methyl + chlorimuron ethyl at 4 g ha⁻¹, twice hand weeding (at 20 and 40 DAT) and unweeded control. Among land management the stale seed bed technique had significantly improved the growth parameters, including plant height, dry matter production and number of tillers. In case of weed management treatments, PoE florypyrauxifen-benzyl recorded significantly taller plants at 45 DAT higher tiller numbers, higher dry matter production and were comparable with penoxsulam + butachlor and twice hand weeding. Significant higher yield attributes (productive tillers m⁻², grains per panicle) and higher grain yield, highest straw yield and lowest weed index were observed for stale seed bed technique. Among weed management practices PoE florypyrauxifen-benzyl recorded with significant higher number of productive tillers, higher number of grains per panicle, higher grain yield and lower weed index which were on par with PoE penoxsulam + butachlor and twice hand weeding.

Keywords: Stale seed bed, penoxsulam + butachlor, florypyrauxifen-benzyl, grain yield

Introduction

Rice (*Oryza sativa* L.) is a vital staple food for more than half of the world's population and plays a pivotal role in ensuring food and nutritional security, particularly in Asia. In India, rice contributes nearly 22-25 per cent of the total cereal production (FAO, 2023) [8]. In Kerala, however, the area under rice cultivation has been declining steadily due to labour scarcity, increased production costs, and competing land-use demands, thereby necessitating the adoption of efficient and sustainable production strategies (Thomas *et al.*, 2022) [27]. Among the various production constraints faced in transplanted rice ecosystems, weed infestation and inadequate land preparation practices remain major factors responsible for substantial yield losses.

Weeds are recognized as one of the most serious biological constraints in rice cultivation. Under unmanaged conditions, weed competition can result in 30-80 per cent yield loss, depending on species composition and crop establishment methods (Chauhan and Opena, 2020) [4]. Effective early-season weed management markedly enhances crop vigour and productivity (Sreedevi, 2020) [26] (Padmaja and Ramprakash, 2022) [14].

Land preparation is another important factor influencing weed emergence, nutrient availability, and crop establishment. Conventional ploughing practices often stimulate weed flushes by exposing buried weed seeds to favourable germination conditions. The stale seedbed technique, wherein an initial weed flush is allowed to germinate and subsequently destroyed prior to transplanting, has emerged as a promising approach for reducing the active weed seedbank and improving early crop performance.

With increasing labour scarcity, chemical weed management has been gaining importance in

Kerala. Pre-emergence application of oxyfluorfen has shown excellent efficacy against broad-leaf weeds and sedges in rice-based systems (Singh *et al.*, 2020) ^[23]. Post-emergence herbicides such as penoxsulam, butachlor, florypyrauxifen-benzyl, and the metsulfuron-methyl + chlorimuron-ethyl combination have demonstrated high weed control efficiency and crop selectivity under Kerala conditions, with multiple KAU-led trials validating their advantage in enhancing yield (Venkatesh, 2021) ^[28] (Ahmed *et al.*, 2021) ^[1] (Rizal and Arbiwati, 2024) ^[19]. Florypyrauxifen-benzyl, in particular, has recently gained prominence due to its strong efficacy against broad-leaf and sedge weeds, with field evaluations in Kerala recording improved early crop growth, higher weed control efficiency, and enhanced grain productivity (Gao *et al.*, 2022) ^[9]. Appropriate land preparation practices and weed management strategies are essential to ensure weed-free conditions during the critical competition period (20-45 DAT), thereby supporting improved crop growth and yield formation. Hence the present investigation was undertaken to evaluate the influence of different land management and weed management practices on the growth, yield, and weed dynamics of transplanted rice.

Materials and Methods

The field experiment was conducted at the State Seed Farm, Kottarakkara, during November 2024 to March 2025. The soil of the experimental site was acidic in reaction (pH 4.67), with medium available nitrogen (365.34 kg ha⁻¹), low available phosphorus (18.32 kg ha⁻¹) and medium potassium status (188.42 kg ha⁻¹). The experiment was laid out in a split plot design and replicated four times. The main plot treatments consisted of three land management practices, viz., L₁: conventional tillage (three ploughings followed by planking), L₂: farmers' practice (two ploughings followed by planking), and L₃: stale seedbed technique (two ploughings followed by planking after a gap of two weeks). The sub-plot treatments comprised six weed management practices: w₁: pre-emergence application of oxyfluorfen at 0.15 kg ha⁻¹, w₂: post-emergence application of penoxsulam + butachlor at 820 g ha⁻¹, w₃: post-emergence application of florypyrauxifen-benzyl at 31.25 g ha⁻¹, w₄: post-emergence application of metsulfuron-methyl + chlorimuron-ethyl at 4 g ha⁻¹, w₅: hand weeding twice at 20 and 40 DAT, and w₆: unweeded control.

In treatment W₁, the pre-emergence herbicide was applied four days prior to transplanting, while the post-emergence herbicides under W₂, W₃ and W₄ were applied at 18 DAT, coinciding with the 2-4 leaf stage of the dominant weed flora. The rice variety Uma (Mo 16), a medium-duration variety, was transplanted at a spacing of 20 cm × 10 cm, following the Package of Practices recommendations of the Kerala Agricultural University. Twenty-five-day-old seedlings were transplanted at the rate of two seedlings per hill. All cultural operations such as fertilizer application, irrigation and plant protection measures were adopted as per KAU guidelines.

Nutrient management was done as per the recommended dose, and all other operations were performed uniformly across treatments. Herbicides were applied using a knapsack sprayer fitted with a flat-fan nozzle, ensuring proper coverage. Spray solutions for post-emergence applications were prepared as per recommended concentrations and applied under calm atmospheric conditions during the late afternoon hours. The growth and yield attributes such as plant height, number of tillers, total dry matter production, yield components, grain yield and straw yield were recorded following the standard procedures applicable to rice crop research. The recorded data were

subjected to statistical analysis.

Results and Discussion

1. Effect of land management and weed management on growth attributes of rice

Growth parameters

Land and weed management practices exerted a significant influence on the growth attributes of rice. Growth parameters such as plant height, number of tillers per square meter and dry matter production were statistically influenced by the integrated management practices evaluated in transplanted rice. The combined effect of land preparation techniques and weed management interventions showed marked variation in crop growth throughout the crop growth period (Table1).

1.1 Plant height

Plant height was significantly influenced by land management practices at all the observational stages. The analyzed data revealed that the stale seedbed technique (L₃) recorded markedly taller plants at 15, 30 and 45 DAT and at harvest (29.72, 44.03, 58.70 and 113.88 cm, respectively), and was significantly superior to the remaining land management treatments (Table1). The superiority of the stale seedbed method may be attributed to the early removal of the initial flush of weeds, resulting in a relatively weed-free environment during the early growth stages. This would have ensured reduced competition for nutrients, moisture and light, thereby enabling the rice crop to establish vigorously. Similar findings on the effectiveness of stale seedbed practices in enhancing plant height in rice have been reported by Singh *et al.* (2018) ^[24], Karri and Balasubramanian (2024) ^[11] and Chandel *et al.* (2025) ^[3].

Weed management practices also had a significant effect on plant height at all growth stages. At 15 DAT, pre-emergence application of oxyfluorfen @ 0.15 kg ha⁻¹ (W₁) resulted in the tallest plants (26.33 cm). At 30 DAT, significantly taller plants were recorded with post-emergence application of florypyrauxifen-benzyl @ 31.25 g ha⁻¹ (W₃) (41.36 cm), which remained statistically comparable with penoxsulam + butachlor @ 820 g ha⁻¹ (W₂) and hand weeding twice at 20 and 40 DAT (W₅). At 45 DAT and at harvest, treatments W₂, W₃ and W₅ continued to maintain significantly taller plants (54.43-56.33 cm at 45 DAT and 117.45-118.61 cm at harvest) (Table1). The enhanced plant height observed under oxyfluorfen during early growth (W₁), and under florypyrauxifen-benzyl (W₃) and penoxsulam + butachlor (W₂) during later growth stages, may be attributed to their superior weed suppression ability, which ensured minimal competition throughout the crop growth cycle. The present findings are consistent with those of Sreedevi (2020) ^[26], Wright *et al.* (2020) ^[29], Chandel *et al.* (2025) ^[3], Mohamed *et al.* (2025) ^[12], who reported that effective early- and mid-season weed control through oxyfluorfen, florypyrauxifen-benzyl, penoxsulam + butachlor and hand weeding resulted in improved vegetative growth and enhanced plant height in transplanted rice.

1.2 Number of tillers m⁻²

Land management practices exerted a significant influence on the number of tillers per square meter at all stages of observation. The stale seedbed technique (L₃) recorded the highest number of tillers at 15, 30 and 45 DAT and at harvest (173.21, 392.33, 505.71 and 485.25, respectively), and was significantly superior to the remaining land preparation methods (Table1). The lowest number of tillers was observed under the farmers' practice (L₂) across all growth stages. The superiority

of the stale seedbed method in promoting tiller production may be attributed to the early destruction of the first weed flush, which created a favourable environment for crop establishment, reduced early competition and allowed the rice plants to initiate and maintain vigorous tillering throughout the growth period. In contrast, the farmers' practice experienced early weed

interference and relatively poorer soil conditions, which restricted the ability of the crop to produce and sustain tillers at successive stages. These findings corroborate the results reported by Renjan and George (2018)^[17], Yadav *et al.* (2019)^[30] and Wright *et al.* (2020)^[29].

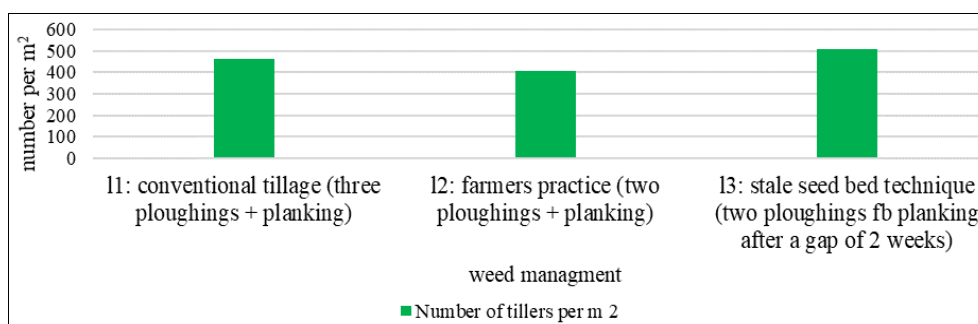


Fig 1: Effect of land management in number of tillers per m² in transplanted rice, no.

Weed management practices also showed a significant effect on the number of tillers per square metre at all observation stages. At 15 DAT, pre-emergence application of oxyfluorfen @ 0.15 kg ha⁻¹ (W₁) recorded a significantly higher number of tillers (155.25). At 30 DAT, post-emergence application of florypyrauxifen-benzyl @ 31.25 g ha⁻¹ (W₃) resulted in a significantly higher number of tillers (384.33), which remained statistically comparable with penoxsulam + butachlor @ 820 g ha⁻¹ (W₂) and hand weeding twice at 20 and 40 DAT (W₅). At 45 DAT and at harvest, W₃ continued to record significantly higher tiller production (494.58 and 463.50 tillers m⁻², respectively), and remained at par with W₂ and W₅. The lowest

number of tillers was consistently recorded in the unweeded control (W₆) (Table1). The enhanced tiller production under oxyfluorfen at 15 DAT and under florypyrauxifen-benzyl, penoxsulam + butachlor and hand weeding at later stages may be attributed to effective suppression of early and subsequent weed flushes, which minimized competition for light, nutrients and space, enabling the rice plants to allocate resources towards active tiller formation. Conversely, the continuous weed pressure in the unweeded control restricted tiller development at all stages of crop growth. Similar observations were reported by Mohamed *et al.* (2025)^[12] and Shende *et al.* (2025)^[21].

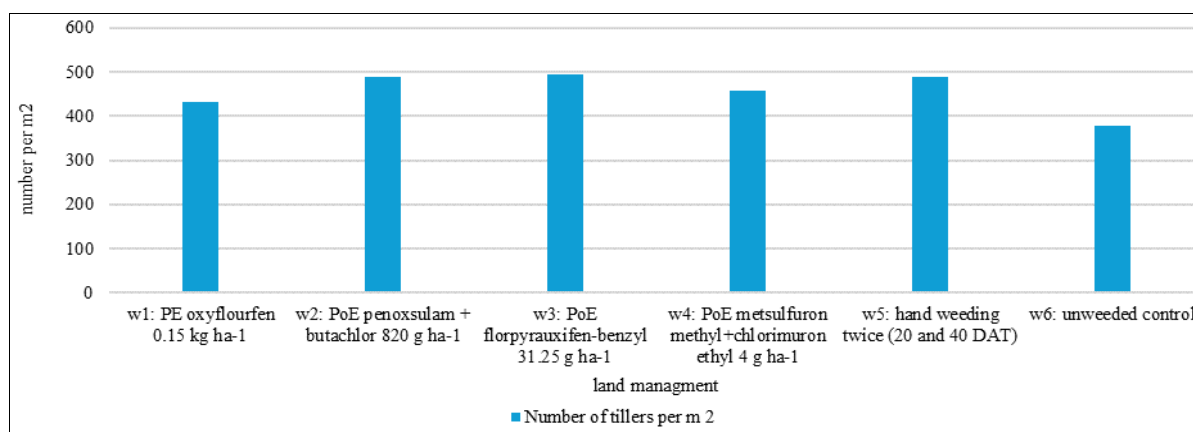


Fig 2: Effect of weed management in number of tillers per m² in transplanted rice, no.

1.3 Leaf area index (LAI)

Land management treatments significantly influenced the leaf area index (LAI) of rice at 45 DAT. Among the treatments, the stale seedbed technique (L₃) recorded the highest LAI (4.53), while the lowest LAI (3.90) was observed under the farmers' practice (L₂) (Table1). The higher LAI under L₃ may be attributed to the early removal of the initial weed flush and the improved soil conditions created during land preparation, which facilitated the development of a wider leaf canopy during the active vegetative phase. Conversely, the farmers' practice experienced greater early weed competition and less favourable field conditions, which limited canopy development and resulted in a lower LAI. These findings are supported by the observations of Karri and Balasubramanian (2024)^[11].

Weed management practices also showed a significant influence

on LAI at 45 DAT. Hand weeding twice at 20 and 40 DAT (W₅) recorded the highest LAI (4.69), which remained statistically comparable with post-emergence application of florypyrauxifen-benzyl @ 31.25 g ha⁻¹ (W₃) and penoxsulam + butachlor @ 820 g ha⁻¹ (W₂), which recorded LAI values of 4.64 and 4.55, respectively. The lowest LAI (3.33) was obtained under the unweeded control (W₆) (Table1). The higher LAI values observed with W₅, W₃ and W₂ may be attributed to the maintenance of a weed-free environment during the crucial vegetative growth phase, which enabled the rice plants to expand their leaf area more effectively. In contrast, the continuous weed pressure present in W₆ restricted leaf development and consequently reduced the LAI. Similar results were reported by Rai *et al.* (2025)^[16] and Chandel *et al.* (2025)^[3].

1.4 Dry matter production per plant

Land management practices exerted a significant influence on the dry matter accumulation of rice at harvest. Among the treatments, the stale seedbed technique (L_3) recorded the highest dry matter production (9864 kg ha^{-1}), while the lowest value (8482 kg ha^{-1}) was observed under the farmers' practice (L_2) (Table 1). The higher dry matter accumulation obtained with the stale seedbed method may be attributed to reduced early weed interference and the favourable soil conditions created during land preparation, which enabled the crop to develop a stronger canopy and sustain better vegetative growth up to harvest. Conversely, the farmers' practice experienced greater early weed competition and poorer crop vigour, resulting in reduced biomass accumulation. These findings are consistent with the results reported by Deivasigamani (2016) [7]. In the unweeded control, higher weed biomass and nutrient removal by weeds led to severe competition, reducing plant height and tiller production, ultimately resulting in the lowest crop dry matter

production. Similar observations were reported by Bhat *et al.* (2017) [2].

Weed management practices significantly influenced dry matter production at harvest. Post-emergence application of florypyrauxifen-benzyl @ 31.25 g ha^{-1} (W_3) recorded the highest dry matter production (10380 kg ha^{-1}), which was statistically at par with post-emergence application of penoxsulam + butachlor @ 820 g ha^{-1} (W_2) and hand weeding twice at 20 and 40 DAT (W_5), which recorded 10187 and 10262 kg ha^{-1} , respectively (Table 1). These findings are supported by Wright *et al.* (2020) [29], Rai *et al.* (2025) [16] and Chandel *et al.* (2025) [3]. The increased dry matter accumulation under W_3 , W_2 and W_5 may be attributed to their effective suppression of early and later weed flushes, which provided the rice plants with a weed-free environment throughout the growth period, enabling efficient utilization of nutrients, moisture and sunlight for continuous biomass buildup.

Table 1: Effect of land management and weed management in yield of transplanted rice

Treatment	Plant height				Number of tillers per m^2				Leaf area index	Dry matter production (kg ha^{-1})
	15 DAT	30 DAT	45 DAT	Harvest	15 DAT	30 DAT	45 DAT	Harvest	Harvest	Harvest
Land management (L)										
L_1 : conventional tillage (three ploughings + planking)	21.67 ^b	37.99 ^b	52.56 ^b	107.49 ^b	140.04 ^b	345.58 ^b	460.21 ^b	437.25 ^b	4.22 ^b	9281 ^b
L_2 : farmers practice (two ploughings + planking)	15.38 ^c	29.91 ^c	43.43 ^c	102.02 ^c	96.58 ^c	305.75 ^c	404.16 ^c	359.12 ^c	3.90 ^c	8482 ^c
L_3 : stale seed bed technique (two ploughings fb planking after a gap of 2 weeks)	29.72 ^a	44.03 ^a	58.70 ^a	113.88 ^a	173.21 ^a	392.33 ^a	505.71 ^a	485.25 ^a	4.53 ^a	9864 ^a
S.Em $\pm$	1.76	1.11	1.21	1.27	9.10	6.19	7.62	7.89	0.03	14.14
CD (0.05)	6.103	3.833	4.191	4.404	31.492	21.429	26.363	27.328	0.117	48.948
Weed management practices (W)										
w_1 : PE oxyflourfen 0.15 kg ha^{-1}	26.33 ^a	35.18 ^c	47.99 ^c	97.81 ^c	155.25 ^a	330.83 ^c	433.75 ^c	406.33 ^c	3.90 ^c	8982 ^c
w_2 : PoE penoxsulam + butachlor 820 g ha^{-1}	21.61 ^b	40.04 ^a	54.43 ^a	117.45 ^a	132.58 ^b	372.66 ^a	488.50 ^a	455.16 ^a	4.55 ^a	10187 ^a
w_3 : PoE florypyrauxifen-benzyl 31.25 g ha^{-1}	21.75 ^b	41.36 ^a	56.33 ^a	118.43 ^a	134.75 ^b	384.33 ^a	494.58 ^a	463.50 ^a	4.64 ^a	10380 ^a
w_4 : PoE metsulfuron methyl+chlorimuron ethyl 4 g ha^{-1}	21.44 ^b	37.28 ^b	51.24 ^b	104.49 ^b	133.33 ^b	343.50 ^b	457.50 ^b	426.75 ^b	4.18 ^b	9772 ^b
w_5 : hand weeding twice (20 and 40 DAT)	21.49 ^b	40.32 ^a	55.85 ^a	118.61 ^a	132.08 ^b	372.83 ^a	488.50 ^a	455.00 ^a	4.69 ^a	10262 ^a
w_6 : unweeded control	20.95 ^b	29.69 ^d	43.53 ^d	90.02 ^d	131.66 ^b	283.16 ^d	377.33 ^d	356.50 ^d	3.33 ^d	5669 ^d
S.Em ($\pm$)	0.82	0.72	0.77	1.42	4.158	4.131	4.871	6.115	0.05	81.79
CD (0.05)	2.35	2.05	2.199	4.045	11.844	11.767	13.875	17.418	0.163	232.98

2. Effect of land management and weed management on yield attributes and yield of rice

2.1 Number of productive tillers m^{-2}

Land management practices significantly influenced the number of productive tillers per square metre. The stale seedbed technique (L_3) recorded the highest number of productive tillers (359.00 m^{-2}), while the lowest value (263.83 m^{-2}) was observed under the farmers' practice (L_2) (Table 2). The superiority of the stale seedbed method may be attributed to the early removal of emerging weeds and the favourable soil conditions created during land preparation, which supported strong crop establishment and enabled the plants to retain a greater proportion of tillers up to maturity. In contrast, early weed interference and poorer soil conditions under the farmers' practice restricted effective tiller formation. Similar findings were reported by Singh *et al.* (2018) [24] Karri and Balasubramanian (2024) [11].

Weed management practices also exerted a significant influence on productive tiller count. Post-emergence application of florypyrauxifen-benzyl @ 31.25 g ha^{-1} (W_3) recorded the highest number of productive tillers (350.08 m^{-2}), which remained statistically comparable with penoxsulam + butachlor @ 820 g ha^{-1} (W_2) and hand weeding twice at 20 and 40 DAT (W_5) (Table 2). Similar observations were documented by Chandel *et al.* (2025) [3]. The enhanced productive tiller formation under W_3 , W_2 and W_5 may be attributed to their ability to maintain a weed-free environment during the critical tillering and panicle initiation phases, enabling the crop to direct more assimilates towards productive tiller development compared to treatments under persistent weed competition.

2.2 Number of grains per panicle

Land management practices significantly affected the number of grains per panicle. The stale seedbed technique (L_3) recorded the

highest number of grains per panicle (141.12), while the lowest value (107.75) was observed under the farmers' practice (L_2) (Table 2). The improved grain formation under the stale seedbed method may be attributed to reduced early crop-weed competition and enhanced soil conditions, which promoted stronger tiller growth and better panicle initiation. Conversely, early weed pressure and less favourable soil environments under L_2 restricted reproductive development and reduced grain set. These findings are in accordance with Singh (2013) ^[25] and Chowdhury *et al.* (2024) ^[5].

Weed management practices also significantly influenced the number of grains per panicle. Post-emergence application of florypyrauxifen-benzyl @ 31.25 g ha⁻¹ (W_3) recorded the highest number of grains (144.08), which remained statistically comparable with penoxsulam + butachlor @ 820 g ha⁻¹ (W_2) and hand weeding twice (W_5) (Table 2). The results corroborate the observations of Mohamed *et al.* (2025) ^[12], Rai *et al.* (2025) ^[16] and Chandel *et al.* (2025) ^[3]. The superior grain formation under

W_3 , W_2 and W_5 may be attributed to effective weed suppression during the critical reproductive phase, facilitating better nutrient utilization and promoting fuller panicle development.

2.3 Thousand grain weight

Land management practices did not exert any significant influence on thousand grain weight. Similarly, variations due to weed management practices were found to be non-significant (Table 2). The absence of significant differences across treatments may be attributed to the fact that thousand grain weight is largely governed by the genetic constitution of variety and is generally less responsive to variations in field conditions. Hence, despite differences in weed pressure and soil environment, grain weight remained uniform across treatments. Similar conclusions were reported by Chandel *et al.* (2025) ^[3] and Debbarma *et al.* (2025) ^[6], who observed that cultural and weed management practices did not substantially influence thousand seed weight.

Table 2: Effect of land management and weed management in yield of transplanted rice

Treatment	Number of productive tillers per m ² (no.)	Number of grains per panicle (no.)	Thousand grain weight (g)
Land management (L)			
L_1 : conventional tillage (three ploughings + planking)	326.66 ^b	130.50 ^b	24.09
L_2 : farmers practice (two ploughings + planking)	263.83 ^c	107.75 ^c	23.79
L_3 : stale seed bed technique (two ploughings fb planking after a gap of 2 weeks)	359.00 ^a	141.12 ^a	24.49
S.Em ±	3.186	2.158	0.24
CD (0.05)	11.024	7.469	NS
weed management practices (W)			
w_1 : PE oxyfluorfen 0.15 kg ha ⁻¹	292.25 ^c	115.41 ^c	23.98
w_2 : PoE penoxsulam + butachlor 820 g ha ⁻¹	343.08 ^a	139.58 ^a	24.58
w_3 : PoE florypyrauxifen-benzyl 31.25 g ha ⁻¹	350.08 ^a	144.08 ^a	24.82
w_4 : PoE metsulfuron methyl+chlorimuron ethyl 4 g ha ⁻¹	312.58 ^b	127.33 ^b	24.46
w_5 : hand weeding twice (20 and 40 DAT)	345.08 ^a	139.58 ^a	24.92
w_6 : unweeded control	255.91 ^d	92.75 ^d	21.98
S.Em (±)	3.282	1.582	0.36
CD (0.05)	9.348	4.505	NS

2.4 Grain yield

Land management practices significantly influenced grain yield. The stale seedbed technique (L_3) recorded the highest grain yield (4794 kg ha⁻¹), while the lowest value (4127 kg ha⁻¹) was observed under the farmers' practice (L_2) (Table 3). The increased grain yield under L_3 may be attributed to higher dry matter accumulation, increased number of productive tillers and reduced weed competition throughout the crop growth period. Early elimination of the first weed flush and favourable soil conditions enabled stronger crop establishment and improved panicle development. These results align with the findings of Shivram *et al.* (2020) ^[22], Pooja and Saravanane (2021) ^[15] and Mohapatra *et al.* (2021) ^[13].

Weed management practices also had a significant effect on grain yield. The highest yield (5477 kg ha⁻¹) was recorded under penoxsulam + butachlor @ 820 g ha⁻¹ (W_2), which remained statistically comparable with florypyrauxifen-benzyl @ 31.25 g ha⁻¹ (W_3) and hand weeding twice (W_5) (Table 3). The enhanced yields under W_2 , W_3 and W_5 may be attributed to their superior weed control during the active vegetative and reproductive phases, enabling efficient nutrient utilisation and uninterrupted crop growth. Similar trends were reported by Wright *et al.* (2020) ^[29], Renjan *et al.* (2022) ^[18] and Chandel *et al.* (2025) ^[3].

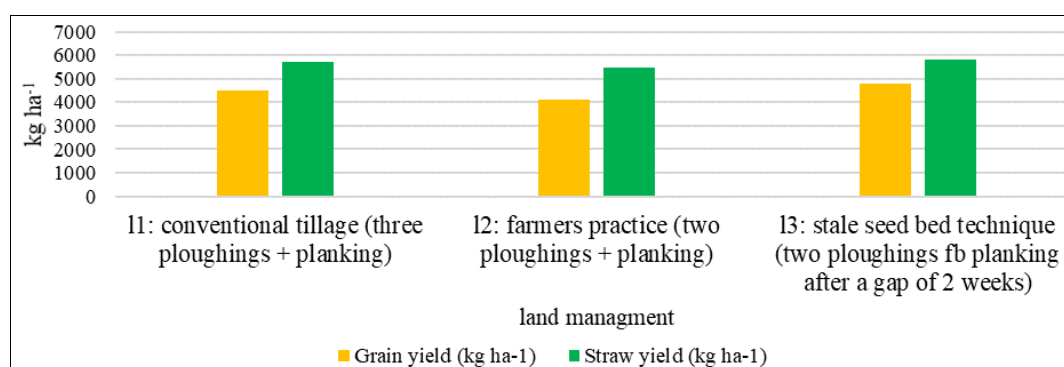
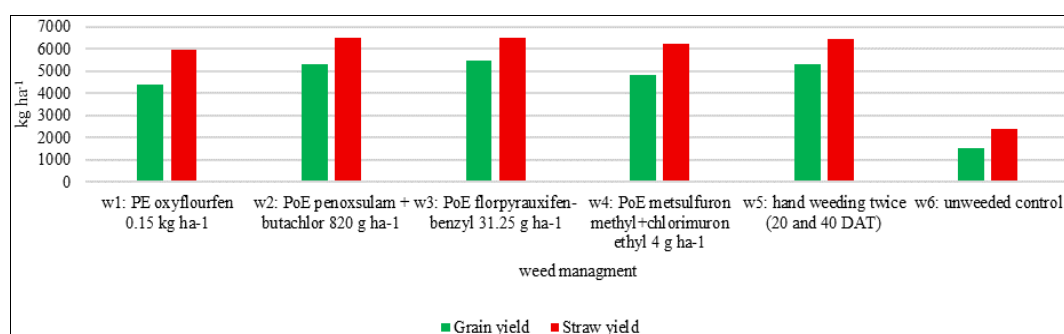
2.5 Straw yield

Land management practices significantly affected straw yield. The stale seedbed technique (L_3) recorded the highest straw yield (5797 kg ha⁻¹), while the lowest yield (5485 kg ha⁻¹) was obtained under the farmers' practice (L_2) (Table 3). The superior straw yield under L_3 may be attributed to improved crop vigour resulting from early weed control and favourable soil conditions, which supported continuous vegetative growth and biomass accumulation. Similar observations were reported by Chandel *et al.* (2025) ^[3].

Weed management practices also influenced straw yield significantly. The highest straw yield (6492 kg ha⁻¹) was recorded with pre-emergence application of oxyfluorfen @ 0.15 kg ha⁻¹ (W_1), which remained on par with penoxsulam + butachlor @ 820 g ha⁻¹ (W_2), florypyrauxifen-benzyl @ 31.25 g ha⁻¹ (W_3) and metsulfuron-methyl + chlorimuron-ethyl @ 4 g ha⁻¹ (W_4) (Table 3). Effective suppression of both early and late-emerging weeds in these treatments ensured a weed-free environment, enabling stronger vegetative growth and higher biomass production. Similar reports were presented by Yadav *et al.* (2019) ^[30] and Chandel *et al.* (2025) ^[3].

Table 3: Effect of land management and weed management in grain, straw yield and harvest index of transplanted rice

Treatment	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index
Land management (L)			
l ₁ : conventional tillage (three ploughings + planking)	4506 ^b	5735 ^a	0.43 ^b
l ₂ : farmers practice (two ploughings + planking)	4127 ^c	5485 ^b	0.42 ^c
l ₃ : stale seed bed technique (two ploughings fb planking after a gap of 2 weeks)	4794 ^a	5797 ^a	0.45 ^a
S.Em ±	35.12	62.473	0.002
CD (0.05)	121.51	216.184	0.007
weed management practices (W)			
w ₁ : PE oxyflourfen 0.15 kg ha ⁻¹	4394 ^c	5952 ^b	0.42 ^c
w ₂ : PoE penoxsulam + butachlor 820 g ha ⁻¹	5328 ^a	6492 ^a	0.45 ^a
w ₃ : PoE florypyrauxifen-benzyl 31.25 g ha ⁻¹	5477 ^a	6485 ^a	0.46 ^a
w ₄ : PoE metsulfuron methyl+chlorimuron ethyl 4 g ha ⁻¹	4811 ^b	6259 ^a	0.44 ^b
w ₅ : hand weeding twice (20 and 40 DAT)	5307 ^a	6447 ^a	0.45 ^a
w ₆ : unweeded control	1538 ^d	2400 ^c	0.39 ^d
S.Em (±)	63.75	111.299	0.003
CD (0.05)	181.57	317.021	0.007

**Fig 3:** Effect of land management in grain yield and straw yield in transplanted rice, no.**Fig 4:** Effect of weed management in grain yield and straw yield in transplanted rice, no

2.6 Harvest index

Land management practices significantly affected harvest index. The stale seedbed technique (L₃) recorded the highest harvest index (0.45), while the lowest (0.42) was observed under the farmers' practice (L₂) (Table 3). The improved harvest index under L₃ may be attributed to enhanced productive tiller formation, stronger panicles and better partitioning of assimilates towards grain, facilitated by reduced early weed interference. These findings agree with those reported by Chandel *et al.* (2025) [3].

Weed management practices also significantly influenced harvest index. The highest value (0.46) was recorded under penoxsulam + butachlor @ 820 g ha⁻¹ (W₂), which remained on par with florypyrauxifen-benzyl @ 31.25 g ha⁻¹ (W₃) and hand weeding twice (W₅) (Table 3). Effective weed suppression throughout critical growth stages under these treatments allowed more efficient biomass allocation towards grain formation. These results align with Yadav *et al.* (2019) [30].

2.7 Weed index

Land management practices significantly influenced weed index. The lowest weed index (19.19%) was recorded under the stale seedbed technique (L₃), whereas the highest value (30.43%) was observed under the farmers' practice (L₂) (Table 4). The lower weed index under L₃ may be attributed to the elimination of the initial weed flush prior to transplanting, which reduced early competition and enabled the crop to perform closer to its potential. Similar observations were reported by Senthilkumar *et al.* (2019) [20].

Weed management practices also had a significant effect on weed index. The lowest weed index (7.68%) was recorded under florypyrauxifen-benzyl @ 31.25 g ha⁻¹ (W₃), which remained at par with penoxsulam + butachlor @ 820 g ha⁻¹ (W₂, 10.19%) and hand weeding twice (W₅, 10.54%). The highest weed index (74.06%) was observed under the unweeded control (W₆) (Table 4). Similar findings were reported by Ghosh *et al.* (2025) [10]. Superior weed suppression under W₃, W₂ and W₅ ensured

minimal yield loss, whereas continuous weed interference in the unweeded control caused substantial yield reduction, leading to a higher weed index.

Table 4: Effect of land management and weed management on Weed index of transplanted rice

Treatment	Weed index (%)
Land management (L)	
l ₁ : conventional tillage (three ploughings + planking)	24.03 ^b
l ₂ : farmers practice (two ploughings + planking)	30.43 ^a
l ₃ : stale seed bed technique (two ploughings fb planking after a gap of 2 weeks)	19.19 ^c
S.Em ±	0.59
CD (0.05)	2.048
Weed management practices (W)	
w ₁ : PE oxyfluorfen 0.15 kg ha ⁻¹	0.42 ^c
w ₂ : PoE penoxsulam + butachlor 820 g ha ⁻¹	0.45 ^a
w ₃ : PoE florypyrauxifen-benzyl 31.25 g ha ⁻¹	0.46 ^a
w ₄ : PoE metsulfuron methyl+chlorimuron ethyl 4 g ha ⁻¹	0.44 ^b
w ₅ : hand weeding twice (20 and 40 DAT)	0.45 ^a
w ₆ : unweeded control	0.39 ^d
S.Em (±)	0.003
CD (0.05)	0.007

Conclusion

The study concluded that the stale seedbed technique significantly improved growth and yield attributes in transplanted rice. Among weed management practices post emergent application of florypyrauxifen-benzyl recorded with significant growth attributes, higher yield attributes like higher number of productive tillers, higher number of grains per panicle resulted higher grain yield and lower weed index. Comparable result also observed with PoE penoxsulam + butachlor and twice hand weeding.

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References

- Ahmed S, Alam MJ, Hossain A. Interactive effect of weeding regimes and rice cultivars under dry direct-seeded condition. *Sustainability*. 2021;13:317.
- Bhat MA, Hussain A, Ganai I, Jehangir A, Teli NA. Bioefficacy of pyrazosulfuron and bensulfuron methyl in combination with pretilachlor against weeds in transplanted rice under temperate conditions of Kashmir. *J Crop Weed*. 2017;13(1):178-82.
- Chandel RS, Singh RS, Shukla G, Chandel A, Patel A. Effect of different establishment and weed management techniques on growth and yield of rice (*Oryza sativa* L.) under irrigated condition. *J Adv Biol Biotechnol*. 2025;28(4):327-38. <https://doi.org/10.9734/jabb/2025/v28i42192>
- Chauhan BS, Opena J. Weed management in rice-based cropping systems. *Crop Prot*. 2020;134:105164.
- Chowdhury M, Khura TK, Upadhyay PK, Parrray RA, Kushwaha HL, Singh C, et al. Assessing vegetation indices and productivity across nitrogen gradients: A comparative study under transplanted and direct-seeded rice. *Front Sustain Food Syst*. 2024;8:1351414. <https://doi.org/10.3389/fsufs.2024.1351414>
- Debbarma S, Pillai SP, Raj SK, Jacob D, Gopinath PP. Prospects of ready-mix herbicides for weed management in transplanted rice in the southern laterites of Kerala, India. *Int J Res Agron*. 2025;8(10):102-9. <https://doi.org/10.33545/2618060X.2025.v8.i10b.3960>
- Deivasigamani S. Study of bio-efficacy and phytotoxicity of new generation herbicides on triafamone and ethoxysulfuron in direct seeded rice (*Oryza sativa* L.). *Int J Appl Sci*. 2016;3(2):106-12.
- FAOSTAT. Food and Agriculture Statistics Database. United Nations FAO; 2023.
- Gao Y, Li J, Shen G, Tian Z. Mode of action of florypyrauxifen-benzyl. *Agronomy*. 2022;12:2656.
- Ghosh S, Reddy MD, Sarkar S, Sagar L. Pre and post emergence herbicides influence on productivity of transplanted rice. *Bhartiya Krishi Anusandhan Patrika*. 2025;40(1):105-9. <https://doi.org/10.18805/BKAP778>
- Karri R, Balasubramanian A. Studies on the effect of stale seedbed technique and herbicides in transplanted rice. *Int J Res Agron*. 2024;7(2):416-9. <https://doi.org/10.33545/2618060X.2024.v7.i2f.331>
- Mohamed H, Pameela P, Antony S, Kumar GK. Efficacy of pre-emergence herbicides in managing weedy rice in wet-seeded rice. *Indian J Weed Sci*. 2025;57(2):230-4. <https://doi.org/10.5958/0974-8164.2025.00039.3>
- Mohapatra S, Tripathy SK, Tripathy S, Mohanty AK. Effect of sequential application of herbicides on productivity and profitability of transplanted rice. *Indian J Weed Sci*. 2021;53(2):129-34.
- Padmaja B, Ramprakash T. Efficacy of new herbicide mixtures in transplanted rice. *IJEC*. 2022;12(12):709-17.
- Pooja K, Saravanane P. Performance of rice cultivars with weed management practices in dry direct-seeded rice. *Indian J Weed Sci*. 2021;53(1):92-4.
- Rai TN, Rai KN, Rai SK, Rai RK, Rai J. Weed and soil health management in transplanted rice (*Oryza sativa* L.). *Int J Agric Plant Sci*. 2025;7(3):23-6.
- Renjan B, George S. Effect of tillage, water regimes and weed management methods on weeds and transplanted rice. *Indian J Weed Sci*. 2018;50(1):13-7.
- Renjan B, George S, Bindu B, Joseph AR. Soil seed bank dynamics of Blood grass (*Isachne miliaceae* Roth ex Roem et Schult) and associated weed flora on tillage, water regimes and herbicides in wet land rice ecosystem. *Frontiers Crop Improve*. 2022;10(1):611-6.
- Rizal AZA, Arbiwati D. Weed management using florypyrauxifen-benzyl + cyhalofop. *Evol Stud Imaginary Cultures*. 2024;8(2):1401-9.
- Senthilkumar D, Arthanari PM, Chinnusamy C, Bharathi C, Lavanya Y. Stale seed bed techniques as successful weed management practice. *J Pharmacogn Phytochem*. 2019;SP-2:120-3.
- Shende S, Bisen JS, Turkar D, Satankar N. Influence of integrated weed management on growth and yield of rice (*Oryza sativa* L.). *Int J Res Agron*. 2025;SP-8(6):121-4. <https://doi.org/10.33545/2618060X.2025.v8.i6Sb.3116>
- Shivram H, Yadav RS, Singh SP, Godara AS, Bijarniya AL, Samota SR. Tillage and weed management effect on productivity of wheat in North-West Rajasthan. *Indian J Weed Sci*. 2020;52(2):127-31.
- Singh A, Yadav S, Singh MK. Efficacy of oxyfluorfen in rice-based systems. *Indian J Weed Sci*. 2020;52(4):321-6.
- Singh GP, Roy DK, Yadav S. Effect of herbicide combinations and hand weeding on growth, yield and weed population in transplanted rice (*Oryza sativa* L.). *Int J Chem*

- Stud. 2018;6(5):154-7.
25. Singh MK. Competitiveness of rice cultivars under stale seedbed in dry direct-seeded rice. *Indian J Weed Sci.* 2013;45(3):171-4.
 26. Sreedevi B. Florpyrauxifen + cyhalofop in aerobic rice. *Curr J Appl Sci Technol.* 2020;39(3):109-22.
 27. Thomas G, Rekha R, Mathew S. Constraints in Kerala rice cultivation. *J Trop Agric.* 2022;60(1):12-20.
 28. Venkatesh B. Herbicide mixtures in transplanted rice. *Indian J Weed Sci.* 2021;53(2):179-81.
 29. Wright HE, Norsworthy JK, Roberts TL, Scott R, Hardke J, Gbur EE. Characterization of rice cultivar response to florpyrauxifen-benzyl. *Weed Technol.* 2020;35(1):82-92.
 30. Yadav DB, Singh N, Kumar J, Yadav A. Penoxsulam + butachlor: A new ready-mix herbicide for control of complex weed flora in transplanted rice. *Indian J Weed Sci.* 2019;51(4):324-7.
<https://doi.org/10.5958/0974-8164.2019.00069.8>