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Hemant Patel
M.Sc. Final Year, Department of Agronomy, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India

T D Pandey
Professor, Department of Agronomy, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India

Dinesh Pandey
Scientist, Department of Agronomy, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India

SK Verma
Principal Scientist, Department of Vegetable Science, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India

NK Chaure
Principal Scientist, Department of Agricultural Statistics, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India

Kiran Sahu
M.Sc. Final Year, Department of Agronomy, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India

Shaili Sahu
M.Sc. Final Year, Department of Entomology, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India

Shivani Gupta
M.Sc. Final Year, Department of Agronomy, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India

Corresponding Author:
Hemant Patel
M.Sc. Final Year, Department of Agronomy, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India

Weed management studies in transplanted rice (*Oryza sativa* L.)

Hemant Patel, TD Pandey, Dinesh Pandey, SK Verma, NK Chaure, Kiran Sahu, Shaili Sahu and Shivani Gupta

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Abstract
An experiment entitled "Weed management studies in transplanted rice (*Oryza sativa* L.)" was undertaken at the Research-cum-Instructional Farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.), during the *kharif* season of 2024-25. The experimental layout followed a Randomized Block Design comprising three replications. The treatments consisted of seven weed management practices *viz*., (T_1) Untreated check, (T_2) Weed free, (T_3) Hand weeding @ 30 DAT (once), (T_4) Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT, (T_5) Bispyribac - Na @ 25 g a.i./ha at 25 DAT, (T_6) Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT) and (T_7) Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT. Observations on plant population, plant height, number of tillers and dry matter accumulation were recorded at different growth stages of the crop. Yield attributes such as number of panicles, panicle length, number of grains per panicle, test weight, grain yield and straw yield were recorded at harvest and subjected to statistical analysis. Total weed density was recorded at 30, 60 and 90 DAT and at harvest and analyzed statistically. Economic parameters such as cost of cultivation, gross return, net return and benefit: cost ratio was also determined. The weed-free treatment (T_2) recorded superior performance in terms of growth parameters, yield attributes, yield, as well as gross and net returns, followed by hand weeding at 30 DAT (once) (T_3). Among the chemical weed control treatments, application of Florpyrauxifen benzyl + Cyhalofop butyl (25 + 125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT (T_7) resulted in higher growth, yield attributes and yield of transplanted rice compared to other weed management practices. However, the highest benefit: cost ratio was obtained under Florpyrauxifen benzyl + Cyhalofop butyl (25 + 125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT (T_7). Hand weeding at 30 DAT (once) (T_3) proved to be the most effective treatment for controlling weed growth. Among the chemical weed management practices, Florpyrauxifen benzyl + Cyhalofop butyl (25 + 125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT (T_7) and Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT) (T_6) were the next best treatments, demonstrating the potential to control a broad spectrum of weeds, including broad-leaved weeds, narrow-leaved weeds and sedges. Higher weed control efficiency at harvest was also recorded under these treatments.

Keywords: Rice, Chlorimuron-ethyl, Florpyrauxifen benzyl, weed index, Cyhalofop butyl and Metsulfuron methyl

Introduction
Rice (*Oryza sativa* L.) belonging to the Poaceae family, is a vital cereal grain, especially in East and Southeast Asia, where it serves as a staple food for nearly half of the world's population. It plays a significant role in human diets, with 95% of global rice production consumed directly by people. Rice is rich in starch and contains 6-7% protein, known as oryzein and about 2.5% fat. Beyond direct consumption, it is also used in the production of alcoholic beverages, starch and rice flour. Globally, rice provides approximately 20% of dietary energy, while wheat and maize contributing 19% and 5%, respectively (Mamun *et al.*, 2011) [13]. For undernourished populations in Asia and Africa, rice is often the most accessible and affordable food, making it indispensable for food security. As a strategic commodity, rice not only addresses global nutritional needs but also has broad implications for economic growth, employment, social stability and peace, particularly in regions where it is a dietary mainstay. Rice is the most important staple food for more than half of the world population. The warm and humid climatic conditions are prevailing in most part of Asia is

well suited to rice production. It is grown in India on 46.38 M ha area and 130.29 Million tonnes production with national average yield 2.809 t ha^{-1} during the year 2021- 22 and in Chhattisgarh, rice is cultivated in 3.76 M ha area and production is 7.90 Mt with average yield 2.101 t ha^{-1} (Anonymous, 2022-23) [2]. With a growing population, India will need to produce more rice to meet rising demand, which is reach expected to 130 million tonnes by 2030.

Effective weed management is essential in transplanted rice, especially during the critical period of competition, to achieve optimal yields. This period, when weeds can severely impact rice development by competing for resources, requires targeted intervention. Controlling weeds during this time is crucial to maximize rice productivity and ensure that crops can grow with minimal interference from competing vegetation (Khaliq *et al.*, 2011) [10].

Weeds are a major concern in rice cultivation, capable of reducing yields by 50 to 90% due to their intense competition for water, sunlight and nutrients, and by acting as hosts for pests and diseases. While, chemical weed control through herbicides is currently the most common approach, challenges are emerging, including shifts in weed flora, the development of multi-herbicide resistance and environmental pollution. These issues underscore the need for sustainable alternatives to weed management that are less reliant on chemical inputs. Historically, since the advent of agriculture, farmers have faced ongoing struggles with weeds, which can significantly impact crop productivity. Although herbicides have provided a convenient solution for weed control, the consequences of their extensive use suggest a pressing need to integrate more sustainable practices, such as crop rotation, mechanical weeding, mulching and the use of cover crops to reduce reliance on herbicides and promote long-term crop and ecosystem health Chemical weed control through herbicides is one of the most effective and widely employed methods for managing weeds in rice. Hand weeding though efficient, it is expensive, time consuming, difficult task and often limited by scarcity of labour at critical period may lead to unsatisfactory weed control practice. To get rid this hurdle usage of herbicides offer a selective and economical control of weeds right from beginning of crop. Due to continuous usage of same mode of action of herbicides like butachlor, pretilachlor *etc.* weed shift is observed in transplanted rice. Weed shift from grasses to broad-leaf weeds and sedges were observed in transplanted rice due to continuous use of same herbicides (Teja *et al.*, 2017) [16]. The most problematic and challenging to manage *Echinocloa colona* in rice field. Due to competition for nutrients, moisture, light and to a lesser extent, space, weeds not only inflict quantitative damage but also lower the quality of produce. The distribution of weeds varies depending on the prevailing meteorological conditions and the quality of the soil. Thus, it is necessary to assess the suitability of new herbicides in the agro-climatic conditions of the Chhattisgarh plain. About 15-20% of the rice crop in Chhattisgarh is transplanted. Due to the drudgery of weeding and the scarcity of labour at the appropriate time, chemical weed control is regarded as a better option than weeding. Pre-emergence herbicides were previously used for weed management, but their use was limited due to their timely application with adequate soil moisture. As a result, appropriate post-emergence herbicides are required based on the weed flora in transplanted rice.

Materials and methods

A field experiment entitled "Weed management studies in transplanted rice (*Oryza sativa* L.)" was conducted at Research cum Instructional Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.) during *kharif* season 2024-25. The experiment was laid out in Randomized Block Design with three replications. The treatments consisted of seven weed management practices *viz*., (T_1) Untreated check, (T_2) Weed free, (T_3) Hand weeding @ 30 DAT (once), (T_4) Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT, (T_5) Bispyribac - Na @ 25 g a.i./ha at 25 DAT, (T_6) Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT) and (T_7) Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT. Observations on plant population, plant height, number of tillers and dry matter accumulation were recorded at different time intervals and number of pods, number of panicles, panicle length, number of grains, test weight, grain yield and straw yield of transplanted rice crop were recorded at harvest and statistically analyzed. The total weed density and total production of dry matter by weeds were recorded at 30, 60, 90 DAT and at harvest and statistically analyzed. The crop growth rate, relative growth rate, harvest index, weed index, weed density, weed control efficiency and economics of rice as a cost of cultivation, net return, gross return and benefit: cost ratio were also worked out.

Results and discussions

Crop parameters

1. Plant height at 30, 60, 90 DAT and at harvest revealed significant differences among the treatments. At 30 DAT, significantly taller plants were recorded under T_2 - Weed free, followed by T_3 - Hand weeding @ 30 DAT (once). Among herbicidal treatments, T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT and T_6 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT) recorded higher plant height than T_4 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT and T_5 - Bispyribac-Na @ 25 g a.i. ha^{-1} at 25 DAT, while the lowest was observed in T_1 - Untreated check. At 60, 90 DAT and at harvest, significantly taller plants were recorded under T_2 - Weed free, followed by T_3 - Hand weeding @ 30 DAT (once), T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT and T_6 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT), whereas T_1 - Untreated check consistently recorded the lowest plant height.
2. Number of tillers $hill^{-1}$ at 30, 60, 90 DAT and at harvest showed significant variation among treatments. At 30 DAT, higher tillering was recorded under T_2 - Weed free, followed by T_3 - Hand weeding @ 30 DAT (once), T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT and T_6 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT), while T_1 - Untreated check recorded the minimum. At 60, 90 DAT and at harvest, T_2 - Weed free recorded the highest number of tillers $hill^{-1}$, followed by T_3 - Hand weeding @ 30 DAT (once), T_7 -

Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT and T_6 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT), whereas T_1 - Untreated check consistently recorded the lowest tillering.

3. Dry matter accumulation per plant at 30 DAT was highest under T_2 - Weed free, followed by T_3 - Hand weeding @ 30 DAT (once), T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT and T_6 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT), while T_1 - Untreated check recorded the lowest value. At 60, 90 DAT and at harvest, T_2 - Weed free recorded the highest dry matter accumulation, followed by T_3 - Hand weeding @ 30 DAT (once), T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT and T_6 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT), whereas T_1 - Untreated check recorded the lowest dry matter accumulation.
4. Yield attributes such as number of panicles $hill^{-1}$, panicle length, number of grains $panicle^{-1}$ and test weight were maximum under T_2 - Weed free, followed by T_3 - Hand weeding @ 30 DAT (once), T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25 + 125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT and T_6 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT), whereas comparatively lower values were recorded under T_4 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT and T_5 - Bispyribac-Na @ 25 g a.i. ha^{-1} at 25 DAT, and minimum values were observed in T_1 - Untreated check.
5. Grain and straw yield of transplanted rice were maximum under T_2 - Weed free (49.85 and 58.32 q ha^{-1}), followed by T_3 - Hand weeding @ 30 DAT (once) (42.86 and 53.43 q ha^{-1}), T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25 + 125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT (40.18 and 50.44 q ha^{-1}) and T_6 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT) (39.22 and 49.28 q ha^{-1}), whereas comparatively lower yields were recorded under T_4 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT and T_5 - Bispyribac-Na @ 25 g a.i. ha^{-1} at 25 DAT, and the minimum grain and straw yield were recorded in T_1 - Untreated check (21.35 and 31.29 q ha^{-1}).
6. Harvest index of transplanted rice was not significantly influenced by treatments; however, numerically higher harvest index was recorded under T_2 - Weed free (46.08%), followed by T_3 - Hand weeding @ 30 DAT (once) (44.51%), T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT (44.34-44.49%) and T_6 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT) (44.32-44.44%), whereas lower values were recorded under T_4 - Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT (43.86%) and T_5 - Bispyribac-Na @ 25 g a.i. ha^{-1} at 25 DAT (43.48%), and the minimum harvest index was observed in T_1 - Untreated check (40.56%).

Weed parameters

1. Total weed density (sedges, grasses and broad-leaved weeds) was recorded at 30, 60, 90 DAT and at harvest. At 30 DAT, the minimum total weed density was observed under weed-free (T_2 - Weed free), which recorded complete suppression of weeds (0.00 m^{-2}); however, among the weed control treatments, Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT (T_7 - 30.67 m^{-2}) recorded the lowest total weed density, followed by Fenoxaprop-p-ethyl @ 60 g a.i. ha^{-1} at 25 DAT + Chlorimuron-ethyl + Metsulfuron methyl @ 20 g a.i. ha^{-1} at 25 DAT (T_6 - 31.85 m^{-2}) and Hand weeding @ 30 DAT (T_3 - 52.38 m^{-2}). At 60 DAT, significantly lowest total weed density was recorded under weed-free (T_2 - 0.00 m^{-2}), while among the treatments, Hand weeding @ 30 DAT (T_3 - 10.01 m^{-2}) recorded the lowest weed density, followed by T_6 (13.84 m^{-2}) and T_7 (14.78 m^{-2}). At 90 DAT, a similar trend was observed where weed-free (T_2) recorded zero weed density, and among the weed control treatments, Hand weeding @ 30 DAT (T_3 - 11.75 m^{-2}) recorded the lowest total weed density, followed by T_7 (16.04 m^{-2}) and T_6 (17.39 m^{-2}), whereas Fenoxaprop-p-ethyl (T_4 - 39.25 m^{-2}) and Bispyribac sodium (T_5 - 35.19 m^{-2}) were comparatively less effective. At harvest, weed-free (T_2) maintained complete suppression of weeds (0.00 m^{-2}), and among the weed control treatments, Hand weeding @ 30 DAT (T_3 - 13.55 m^{-2}) recorded the lowest total weed density, followed by T_7 (18.03 m^{-2}) and T_6 (18.61 m^{-2}), while the maximum total weed density was recorded under untreated check (T_1 - 68.64 m^{-2}) at all stages of observation.
2. Weed control efficiency (WCE) was recorded at 30, 60, 90 DAT and at harvest. At 30 DAT, the maximum WCE was observed in T_2 - Weed free (100%), followed by Florpyrauxifen benzyl + Cyhalofop butyl (T_7 - 42.12%) and Fenoxaprop-p-ethyl + Chlorimuron-ethyl + Metsulfuron methyl (T_6 - 39.89%), which were significantly superior to single herbicide applications. The lowest WCE was recorded in T_1 - Untreated check (0%). At 60 DAT, 90 DAT and at harvest, T_2 maintained complete weed suppression (100%). Among weed control treatments, T_3 - Hand weeding @ 30 DAT, T_7 and T_6 consistently recorded higher WCE (up to 80.25%, 74.94% and 72.89%, respectively). Single herbicide treatments T_4 - Fenoxaprop-p-ethyl and T_5 - Bispyribac sodium showed moderate WCE, while T_1 remained ineffective throughout the crop period.

Economics

The highest cost of cultivation (₹ 61,150 ha^{-1}) was recorded under T_2 - Weed free, followed by T_3 - Hand weeding @ 30 DAT (₹ 54,350 ha^{-1}), while the minimum cost was noted under the untreated check (T_1). The highest gross return (₹ 1,60,367.45 ha^{-1}) and net return (₹ 99,217.45 ha^{-1}) were obtained under T_2 - Weed free, followed by T_3 - Hand weeding @ 30 DAT (gross return ₹ 1,38,209.36 ha^{-1} and net return ₹ 83,859.36 ha^{-1}) and T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g L^{-1}) @ 150 g a.i. ha^{-1} at 25 DAT (gross return ₹ 1,23,122.24 ha^{-1} and net return ₹ 77,112.24 ha^{-1}). The highest benefit: cost ratio (2.68:1) was recorded under T_7 - Florpyrauxifen benzyl + Cyhalofop butyl, followed closely by T_2 - Weed free (2.62:1). However, the minimum gross return, net return and B:C ratio were observed under the untreated check (T_1).

Table 1: Effect of weed management practices on plant height of transplanted rice (*Oryza sativa* L.)

Treatment details	Plant height (cm)			
	30 DAT	60 DAT	90 DAT	At harvest
T_1 - Untreated check	42.12	73.32	92.45	90.32
T_2 - Weed free	47.56	97.56	124.56	122.43
T_3 - Hand weeding @ 30 DAT (once)	46.28	92.91	117.43	115.30
T_4 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT	43.53	81.45	101.37	99.24
T_5 - Bispyribac - Na @ 25 g a.i./ha at 25 DAT	43.47	79.43	99.76	97.63
T_6 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT)	46.18	90.43	112.35	110.22
T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT	46.96	91.22	114.04	111.91
Sem (±)	0.38	1.48	2.25	2.23
CD (5%)	1.18	4.57	6.94	6.88

Table 2: Effect of weed management practices on number of tillers of transplanted rice (*Oryza sativa* L.)

Treatment details	Number of tillers (hill^{-1})			
	30 DAT	60 DAT	90 DAT	At harvest
T_1 - Untreated check	4.56	5.52	5.87	5.75
T_2 - Weed free	7.23	12.45	13.25	12.97
T_3 - Hand weeding @ 30 DAT (once)	6.68	10.87	11.57	11.32
T_4 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT	5.49	7.65	8.14	7.97
T_5 - Bispyribac - Na @ 25 g a.i./ha at 25 DAT	5.38	7.43	7.91	7.74
T_6 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT)	6.54	9.79	10.28	10.07
T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT	6.45	10.32	10.92	10.71
Sem (±)	0.16	0.48	0.51	0.46
CD (5%)	0.49	1.47	1.52	1.42

Table 3: Effect of weed management practices on dry matter accumulation of transplanted rice (*Oryza sativa* L.)

Treatment details	Dry matter accumulation (g plant^{-1})			
	30 DAT	60 DAT	90 DAT	At harvest
T_1 - Untreated check	8.52	49.43	92.43	99.36
T_2 - Weed free	11.03	64.85	122.65	131.83
T_3 - Hand weeding @ 30 DAT (once)	10.47	61.06	117.52	125.72
T_4 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT	9.26	53.18	103.52	110.47
T_5 - Bispyribac - Na @ 25 g a.i./ha at 25 DAT	9.12	52.65	99.84	107.24
T_6 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT)	10.06	59.24	113.34	121.64
T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT	10.25	60.52	115.15	123.65
Sem (±)	0.15	0.97	1.64	1.68
CD (5%)	0.47	2.98	5.03	5.17

Table 4: Effect of weed management practices on number of panicles, panicle length, number of grains and test weight of transplanted rice (*Oryza sativa* L.)

Treatment details	Number of panicles hill^{-1}	Panicle length (cm)	Number of grains panicle^{-1}	Test weight (g)
T_1 - Untreated check	5.61	12.55	113.21	19.73
T_2 - Weed free	9.74	25.43	155.65	26.54
T_3 - Hand weeding @ 30 DAT (once)	9.05	22.89	146.12	25.27
T_4 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT	7.51	17.03	125.03	22.13
T_5 - Bispyribac - Na @ 25 g a.i./ha at 25 DAT	7.24	15.93	122.45	21.65
T_6 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT)	8.75	21.54	141.57	24.28
T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT	8.92	22.37	143.74	24.92
Sem (±)	0.19	0.77	2.85	0.38
CD (5%) =	0.59	2.37	8.78	1.18

Table 5: Effect of weed management practices on grain yield, straw yield and harvest index of transplanted rice (*Oryza sativa* L.)

Treatment details	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
T_1 - Untreated check	21.35	31.29	40.56
T_2 - Weed free	49.85	58.32	46.08
T_3 - Hand weeding @ 30 DAT (once)	42.86	53.43	44.51
T_4 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT	31.04	39.73	43.86
T_5 - Bispyribac - Na @ 25 g a.i./ha at 25 DAT	29.94	38.92	43.48
T_6 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT)	39.22	49.28	44.32
T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT	40.18	50.44	44.34
Sem (±)	1.91	1.93	2.6
CD (5%) =	5.87	5.95	NS

Table 6: Effect of weed management practices on weed density at 30 DAT of transplanted rice (*Oryza sativa* L.)

Treatment details	Weed density (m^{-2}) at 30 DAT			
	Sedges	Grasses	BLWs	Total
T_1 - Untreated check	3.58 (12.33)*	5.45 (29.12)	3.46 (11.44)	7.31 (52.99)
T_2 - Weed free	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_3 - Hand weeding @ 30 DAT (once)	3.56 (12.15)	4.08 (29.01)	2.17 (11.21)	2.27 (52.38)
T_4 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT	2.93 (8.11)	4.98 (24.32)	2.80 (7.34)	6.35 (39.78)
T_5 - Bispyribac - Na @ 25 g a.i./ha at 25 DAT	2.91 (8.02)	4.96 (24.12)	2.75 (7.12)	6.30 (39.27)
T_6 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT)	2.66 (6.55)	4.44 (19.32)	2.53 (5.97)	5.69 (31.85)
T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT	2.57 (6.12)	4.43 (19.10)	2.44 (5.44)	5.58 (30.67)
Sem (±)	0.08	0.12	0.11	0.15
CD (5%) =	0.24	0.35	0.32	0.47

Figures in parentheses are original value

Table 7: Effect of weed management practices on weed density at 60 DAT of transplanted rice (*Oryza sativa* L.)

Treatment details	Weed density (m^{-2}) at 60 DAT			
	Sedges	Grasses	BLWs	Total
T_1 - Untreated check	(3.70 (13.26)*	5.73 (32.28)	3.65 (12.85)	7.67 (58.41)
T_2 - Weed free	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_3 - Hand weeding @ 30 DAT (once)	1.67 (1.76)	7.68 (4.43)	1.93 (3.24)	3.24 (10.01)
T_4 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT	2.68 (6.73)	4.30 (18.02)	2.38 (5.17)	5.51 (29.94)
T_5 - Bispyribac - Na @ 25 g a.i./ha at 25 DAT	2.73 (6.97)	4.60 (20.66)	2.69 (6.75)	5.90 (34.40)
T_6 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT)	1.98 (2.14)	2.61 (5.32)	2.14 (4.07)	3.79 (13.84)
T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT	2.02 (1.96)	2.74 (5.01)	2.15 (4.11)	3.91 (14.78)
Sem (±)	0.16	0.10	0.07	0.15
CD (5%) =	0.48	0.31	0.21	0.44

Figures in parentheses are original value

Table 8: Effect of weed management practices on weed density at 90 DAT of transplanted rice (*Oryza sativa* L.)

Treatment details	Weed density (m^{-2}) at 90 DAT			
	Sedges	Grasses	BLWs	Total
T_1 - Untreated check	3.76 (13.67)*	5.98 (35.31)	4.14 (15.04)	8.03 (64.03)
T_2 - Weed free	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_3 - Hand weeding @ 30 DAT (once)	1.47 (2.21)	2.37 (5.22)	2.38 (4.77)	3.50 (11.75)
T_4 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT	2.75 (7.05)	4.88 (23.33)	3.24 (8.86)	6.30 (39.25)
T_5 - Bispyribac - Na @ 25 g a.i./ha at 25 DAT	2.84 (7.55)	4.56 (20.43)	3.09 (7.21)	5.97 (35.19)
T_6 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT)	1.83 (2.86)	3.06 (8.97)	2.64 (5.55)	4.23 (17.39)
T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT	1.72 (2.55)	2.92 (8.04)	2.61 (5.44)	4.07 (16.04)
Sem (±)	0.12	0.15	0.09	0.12
CD (5%) =	0.36	0.44	0.26	0.35

Figures in parentheses are original value

Table 9: Effect of weed management practices on weed density at harvest of transplanted rice (*Oryza sativa* L.)

Treatment details	Weed density (m^{-2}) at harvest			
	Sedges	Grasses	BLWs	Total
T_1 - Untreated check	3.92(14.95)*	6.13 (37.04)	4.14 (16.64)	8.32 (68.64)
T_2 - Weed free	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_3 - Hand weeding @ 30 DAT (once)	1.71 (2.33)	2.52 (6.11)	2.39 (5.23)	3.75 (13.55)
T_4 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT	2.95 (8.21)	5.08 (25.44)	3.24 (10.04)	6.65 (43.70)
T_5 - Bispyribac - Na @ 25 g a.i./ha at 25 DAT	3.01 (8.64)	4.72 (21.78)	3.09 (9.05)	6.32 (39.49)
T_6 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT)	1.93 (3.41)	3.01 (8.75)	2.64 (6.45)	4.37 (18.61)
T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT	1.92 (3.23)	2.94 (8.45)	2.61 (6.34)	4.30 (18.03)
Sem (±)	0.19	0.23	0.26	0.14
CD (5%) =	0.58	0.71	0.81	0.41

Figures in parentheses are original value

Table 10: Effect of weed management practices on weed control efficiency of transplanted rice (*Oryza sativa* L.)

Treatment details	Weed control efficiency (%)			
	30 DAT	60 DAT	90 DAT	At harvest
T_1 - Untreated check	0.00	0.00	0.00	0.00
T_2 - Weed free	100.00	100.00	100.00	100.00
T_3 - Hand weeding @ 30 DAT (once)	0.00	82.86	81.64	80.25
T_4 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT	24.93	48.74	38.70	36.34
T_5 - Bispyribac - Na @ 25 g a.i./ha at 25 DAT	25.89	41.11	45.03	42.48
T_6 - Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT)	39.89	76.29	72.84	72.89
T_7 - Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT	42.12	74.68	74.94	73.73
Sem (±)	2.74	2.58	2.03	1.97
CD (5%) =	8.43	7.94	6.25	6.08

Conclusion

Weed free (T_2) have registered higher growth, yield attributes and yield as well as gross and net return followed by Hand weeding @ 30 DAT (once) (T_3), among the chemical weed control Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT (T_7) have recorded higher growth, yield attributes and yield of transplanted rice as compared to other weed management practices. However, the benefit: cost ratio was higher under Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT (T_7). Hand weeding @ 30 DAT (once) (T_3) were best performing treatment to control weed growth, among the chemical weed management Florpyrauxifen benzyl + Cyhalofop butyl (25+125 g/L) @ 150 g a.i./ha at 25 DAT (T_7) and Fenoxaprop-p-ethyl @ 60 g a.i./ha at 25 DAT + (Chlorimuron-ethyl + Metsulfuron methyl 20 g a.i./ha at 25 DAT) (T_6) were next best performing treatments, it had the potential to control broad spectrum of weeds *i.e.* broad, narrow leaved weeds and sedges. Weed control efficiency at harvest also recorded higher values in both the treatments.

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