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WEED DYNAMICS AND YIELD PERFORMANCE OF DRY DIRECT SEEDED RICE UNDER ON-FARM CONDITIONS IN THE CENTRAL TELANGANA ZONE

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ABSTRACT

A field investigation entitled *"*On-Farm Research on Weed Management in Dry Direct Seeded Rice*"* was conducted during *Vanakalam, 2024* at three locations (Somavaram, Thatipudi and Wyra villages) in Khammam district under the Central Telangana Zone. The study aimed to evaluate the efficacy of different post-emergence herbicide mixtures in controlling complex weed flora and improving yield and economics in dry-DSR. The experiment consisted of three treatments: T_1: Penoxsulam 1.02% + Cyhalofop-butyl 5.1% OD @135 g a.i. ha^{-1} (PoE, 15–20 DAS); T_2 : Triafamone 20% + Ethoxysulfuron 10% WG @44 + 22.5 g a.i. ha^{-1} (PoE, 15–20 DAS) fb Fenoxaprop-p-ethyl 6.7% w/w @60.38 g a.i. ha^{-1} (40–45 DAS); and Farmer Practice (FP): Metsulfuron methyl 10% + Chlorimuron ethyl 10% WP @4 g a.i. ha^{-1} + Bispyribac sodium 10% SC @25 g a.i. ha^{-1} (15–20 DAS) fb Fenoxaprop-p-ethyl 6.7% @60.38 g a.i. ha^{-1} (40–45 DAS). Results revealed that T_2 recorded significantly lower weed density and dry weight, higher weed control efficiency (WCE) and superior yield parameters. The grain yield was highest with T_2 (7045 kg ha^{-1}) followed by T_1 (6637 kg ha^{-1}) and FP (6247 kg ha^{-1}). Economic analysis showed maximum net returns (₹1,18,268 ha^{-1}) and B:C ratio (3.70) with T_2. Thus, the sequential use of Triafamone + Ethoxysulfuron followed by Fenoxaprop-p-ethyl proved effective for weed management and yield enhancement in dry-DSR under Telangana conditions.

Keywords: Dry direct seeded rice, herbicide mixture, Triafamone, Ethoxysulfuron, Penoxsulam, economics

Rice (*Oryza sativa L.*) is the most important staple food crop of India, contributing significantly to national food security and rural livelihoods. Traditionally, rice is cultivated through puddled transplanting, which ensures effective weed control and uniform crop establishment. However, this method is highly water- and labour-intensive, posing serious sustainability challenges under current conditions of declining water availability, labour scarcity and rising production costs. In recent years, Dry Direct-Seeded Rice (DSR) has emerged as a viable alternative establishment method that saves water, reduces labour requirements and advances crop maturity. Despite these advantages, the major constraint limiting the widespread adoption of DSR is severe weed infestation during the early growth stages. The absence of standing water, which normally suppresses weed germination in transplanted rice, creates a favourable environment for the emergence of diverse and competitive weed flora. Weed competition during the critical period can drastically reduce rice growth, nutrient uptake, and ultimately grain yield. Therefore, effective weed management is a crucial determinant of the success and productivity of DSR systems.

The Central Telangana Zone characterized by semi-arid climate and variable rainfall patterns is witnessing an increasing shift towards DSR due to the depletion of groundwater and escalating costs of manual transplanting. However, information on weed dynamics, crop-weed competition and yield performance of DSR under on-farm conditions in this region remains limited. Understanding the composition, density and dominance of weed species, along with their impact on crop growth and yield, is essential for formulating integrated and location-specific weed management strategies. Hence, the present study was undertaken to evaluate the weed dynamics and yield performance of Dry Direct-Seeded Rice under on-farm conditions in the Central Telangana Zone. The findings aim to provide a scientific basis for optimizing weed management practices, enhancing productivity and promoting the sustainable adoption of DSR in the region.

Review of Literature

Chauhan and Johnson (2011) emphasized that early-season weed control is critical for DSR, as crop-weed competition during the first 40 DAS significantly reduces yield. Penoxsulam + Cyhalofop-butyl has been reported to effectively control both grassy and broadleaf weeds (Singh et al., 2018). Similarly, Triafamone + Ethoxysulfuron mixtures provide excellent control over complex weed flora including *Echinochloa colona*, *Cyperus iria* and *Fimbristylis miliacea* (Rao et al., 2020).

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Kumar et al. (2021) found that sequential application of Triafamone + Ethoxysulfuron followed by Fenoxaprop-p-ethyl maintained higher weed control efficiency (>85%) and higher yield in DSR. Bispyribac sodium and sulfonylurea mixtures (Metsulfuron methyl + Chlorimuron ethyl) are effective but often inadequate under heavy weed pressure (Yadav et al., 2022). Hence, evaluating new-generation herbicide mixtures in real farm conditions is crucial for improving productivity and profitability of DSR.

MATERIALS AND METHODS

Experimental Site and Soil Characteristics

The on-farm research (OFR) was carried out during *Vanakalam* (*Kharif*) season of 2024 at three farmer fields located in Somavaram, Thatipudi and Wyra villages of Khammam district, Telangana. These locations fall under the Central Telangana Zone and are representative of typical dry direct-seeded rice (DDSR) cultivation conditions in the region. The soils of the experimental sites were shallow to medium black with good drainage. Pre-sowing soil analysis indicated that the soils were low in available nitrogen, medium in available phosphorus, and high in available potassium content.

Experimental Details and Design

The experiment was conducted under the technical supervision of the Agricultural Research Station (ARS), Madhira, functioning under the Professor Jayashankar Telangana Agricultural University (PJTAU). The experiment was laid out under on-farm conditions with a total experimental area of 0.4 ha per farmer, covering an overall area of 1.2 ha per treatment and 3.6 ha in total across the three locations.

The field experiment was arranged in a Randomized Block Design (RBD) with three treatments and replicated across the three locations. The treatments were as follows:

- T_1 : Penoxsulam 1.02% + Cyhalofop-butyl 5.1% OD @ 135 g a.i. ha^{-1} (post-emergence, 15–20 DAS)
- T_2 : Triafamone 20% + Ethoxysulfuron 10% WG @ 44 + 22.5 g a.i. ha^{-1} (post-emergence, 15–20 DAS) followed by Fenoxaprop-p-ethyl 6.7% w/w @ 60.38 g a.i. ha^{-1} (post-emergence, 40–45 DAS)
- FP (Farmer Practice): Metsulfuron methyl 10% + Chlorimuron ethyl 10% WP @ 4 g a.i. ha^{-1} + Bispyribac sodium 10% SC @ 25 g a.i. ha^{-1} (post-emergence, 15–20 DAS) followed by Fenoxaprop-p-ethyl 6.7% w/w @ 60.38 g a.i. ha^{-1} (post-emergence, 40–45 DAS)

Crop Establishment and Management

The rice variety BPT-5204 (Samba Mahsuri) was sown under dry direct-seeded conditions using a seed-cum-fertilizer drill at a row spacing of 20 cm. Recommended seed rate and nutrient management practices as per PJTAU guidelines were adopted uniformly across treatments. A uniform basal dose of nitrogen, phosphorus and potassium was applied at sowing, with the remaining nitrogen top-dressed in two equal splits at tillering and panicle initiation stages.

Irrigation was scheduled as per soil moisture requirements to maintain aerobic conditions during the early crop growth period, followed by intermittent flooding at later stages. All other agronomic practices such as pest and disease management, fertilizer application, and irrigation were followed uniformly for all treatments.

Weed Observation and Data Recording

Weed observations were recorded at 15, 30, 45, and 60 days after sowing (DAS) and at harvest. Weed samples were collected from two randomly selected quadrats (0.25 m^2) per plot, identified, and categorized into grasses, sedges and broad-leaved weeds. Weed counts were expressed as number of weeds per square meter. The collected samples were oven-dried at 65 ± 2 °C until a constant weight was achieved to determine weed dry matter accumulation (g m^{-2}).

The Weed Control Efficiency (WCE) was computed using the formula:

$$WCE (\%) = (WDMc - WDMt)/WDMc \times 100$$

where *WDM_c* = weed dry matter in the control (farmer practice) plot, and *WDM_t* = weed dry matter in the treated plot.

Growth and Yield Observations

Growth parameters such as plant height and number of tillers m^{-2} were recorded at key phenological stages. Yield attributes including number of panicles m^{-2}, grains per panicle, test weight and grain yield (kg ha^{-1}) were recorded at harvest. Grain yield was adjusted to a standard moisture content of 14%. Straw yield was determined after sun-drying and weighed separately.

Statistical Analysis

The recorded data on weed flora, weed density, weed dry weight and yield parameters were subjected to analysis of variance (ANOVA) following Randomized Block Design (RBD) procedures as described by Gomez and Gomez (1984). Treatment means were compared at the 5% level of significance (CD = 0.05) using appropriate statistical software. Data were transformed where necessary to maintain homogeneity of variance.

RESULTS AND DISCUSSION

Weed Flora and Dynamics

The predominant weeds were *Echinochloa colona* (grasses), *Cyperus iria* (sedges) and *Eclipta alba* (broadleaves). Before herbicide application (15 DAS), weed density was uniform across treatments (60–70 weeds m^{-2}). At 20 DAS, T_2 markedly reduced grassy and sedge weed density to 11.7 and 5.5 m^{-2}, respectively, compared to FP (28.3 and 15.6 m^{-2}). Weed dry matter followed a similar trend, indicating superior efficacy of T_2. At 45 DAS, T, maintained the lowest total weed dry matter (6.3 g m^{-2}), followed by T_1 (8.4 g m^{-2}), while FP recorded 13.8 g m^{-2}. The weed control efficiency (WCE) was 85.2% and 78.5% for T_2 and T_1, respectively, significantly higher than FP (62.1%). These results are consistent with those of Kumar et al. (2021), who reported over 80% WCE with Triafamone + Ethoxysulfuron combinations.

Growth and Yield Attributes

The growth and yield attributes of dry direct-seeded rice (DSR) were significantly influenced by weed management practices (Table 1). Among the treatments, both TOP1 and TOP2 exhibited superior performance over the Farmer Practice (FP) in terms of productive tillers and reproductive parameters. Plant height varied slightly among treatments, ranging from 66.1 cm (TOP1) to 68.5 cm (FP). Although FP recorded marginally higher plant height, this may be attributed to greater intra-specific competition due to weed interference rather than true vigor (Singh et al., 2022). The number of hills per square meter was highest under TOP2 (40.8), followed by TOP1 (38.5) and FP (37.9), indicating improved plant establishment and uniform stand in the improved management options. Similar findings were reported by Yadav et al. (2020), who observed that precise weed control and proper seedbed management in DSR enhanced crop establishment and tillering.

TOP2 recorded the highest number of tillers per hill (17.1) and panicles per hill (14.5), which were 7–10% higher than FP. This improvement can be linked to reduced early weed competition, resulting in better light, nutrient, and moisture availability to the crop (Rao *et al.,* 2017). Likewise, grains per panicle were also higher under TOP2 (160.4), followed by TOP1 (154.1), while FP recorded the least (149.1). The increase in productive tillers and grains per panicle under improved weed management has also been noted by Chauhan and Johnson (2011) and Singh et al. (2015), emphasizing that early-season weed control is crucial for maximizing yield potential in DSR.

Table 1. Growth and yield attributes of Dry Direct-Seeded Rice under different weed management practices

Parameter	TOP1	TOP2	FP	Mean ± SD (TOP1)	Mean ± SD (TOP2)	Mean ± SD (FP)
Plant height (cm)	66.1	66.2	68.5	66.1 ± 2.9	66.2 ± 1.5	68.5 ± 3.6
No. of hills/m²	38.5	40.8	37.9	38.5 ± 2.8	40.8 ± 3.5	37.9 ± 1.5
No. of tillers/hill	15.9	17.1	16.3	15.9 ± 0.6	17.1 ± 2.3	16.3 ± 3.2
Panicles/hill	12.7	14.5	10.6	12.7 ± 1.6	14.5 ± 3.2	10.6 ± 1.5
Grains/panicle	154.1	160.4	149.1	154.1 ± 13.2	160.4 ± 31.5	149.1 ± 35.8

Observation: Both TOP1 and TOP2 recorded higher productive tillers and grains/panicle than FP, with TOP2 showing a slight edge in reproductive traits.

Yield and Economics

Grain yield showed significant variation among treatments (Table 2). TOP2 recorded the highest grain yield (7045 kg/ha), followed by TOP1 (6637 kg/ha), and FP (6247 kg/ha). The yield advantage of 6.2% and 9.6% for TOP1 and TOP2, respectively, over FP highlights the efficacy of integrated weed management strategies. The increase in straw yield followed a similar trend, suggesting overall improvement in crop biomass production. The economic analysis revealed that both TOP1 and TOP2 were more profitable compared to FP. The net returns were ₹1,18,268 ha^{-1} and ₹1,11,452 ha^{-1} for TOP2 and TOP1, respectively, against ₹98,290 ha^{-1} for FP. The benefit-cost (B:C) ratios of 3.70 and 3.71 for TOP2 and TOP1, respectively, were substantially higher than that of FP (3.17), indicating better economic efficiency. Similar findings were reported by Mahajan and Chauhan (2013) and Kumar *et al.* (2021), who demonstrated that timely herbicide application combined with cultural practices significantly enhances the profitability of DSR.

Table 2. Yield and economics of Dry Direct-Seeded Rice under different weed management practices

Parameter	TOP1	TOP2	FP	Mean
Grain yield (kg/ha)	6637	7045	6247	6643
Straw yield (kg/ha)	8615	8842	8390	8616
Gross returns (₹/ha)	1,52,643	1,62,035	1,43,673	1,52,784
Cost of cultivation (₹/ha)	41,192	43,767	45,383	43,447
Net returns (₹/ha)	1,11,452	1,18,268	98,290	1,09,337
B:C ratio	3.71	3.70	3.17	-

Interpretation:

TOP1 and TOP2 gave 6–9% higher yield and 10–20% higher net returns than FP. Both technologies were economically superior (B:C H ~ 3.7).

Weed Dynamics and Suppression Efficiency

Weed density and dry matter production were markedly reduced under TOP1 and TOP2 compared to FP at both 15 and 45 DAS (Tables 3 and 4). Before herbicide application (15 DAS), grassy weeds dominated, with densities of 63.7–74.0 no/m² and sedges ranging from 25.0–30.0 no/m². Post-application, TOP2 achieved the highest reduction, lowering grassy weeds by 84% and sedges by 89%, followed by TOP1 (74% and 83%), while FP showed only 62% and 67% reduction, respectively.

At 45 DAS, weed regrowth was substantially lower in the improved technologies. Total weed dry matter was reduced by 60% in TOP1 and 70% in TOP2 compared with FP. These results confirm the sustained effectiveness of the weed control programs in suppressing both early and late-emerging weed flushes. Reduced weed pressure under TOP2 indicates a broader weed control spectrum and prolonged herbicidal efficacy (Singh et al., 2018). Effective early weed control is essential in DSR, as weeds compete strongly during the initial 30–40 days after sowing, affecting crop vigor and tiller production (Chauhan, 2012).

Table 3. Effect of weed management on weed density and dry matter (15 DAS)

Treatment	Grassy Weed Density (no/m²)	Sedges Density (no/m²)	Grassy Weed DM (g/m²)	Sedges DM (g/m²)
TOP1 – Before herbicide	63.7	30.0	40.0	10.5
TOP1 – After herbicide	16.7	5.0	9.5	1.8
TOP2 – Before herbicide	71.0	28.0	41.7	12.2
TOP2 – After herbicide	11.7	3.7	5.5	1.1
Farmer Practice – Before herbicide	74.0	25.0	44.8	11.0
Farmer Practice – After herbicide	28.3	12.3	15.6	8.3

Weed Reduction Efficiency (%):

- **TOP1:** Grassy weeds reduced by 74%, sedges reduced by 83%
- **TOP2:** Grassy weeds reduced by 84%, sedges reduced by 89%
- **FP:** Grassy weeds reduced by 62%, sedges reduced by 67%

Inference: TOP2 was most effective in early weed suppression.

Table 4. Effect of weed management on weed density and dry matter (45 DAS)

Treatment	Grassy Weed Density (no/m²)	Sedges Density (no/m²)	Grassy Weed DM (g/m²)	Sedges DM (g/m²)
TOP1	36.3	9.0	20.6	5.2
TOP2	28.0	11.7	12.2	5.5
Farmer Practice	74.0	28.3	44.8	15.6

Weed Suppression Efficiency (vs FP):

- TOP1 reduced total weed DM by 60%
- TOP2 reduced by 70%

Weed regrowth was significantly lower under both technology options.

Integrated Performance Summary

Averaged over parameters (Table 5), TOP2 recorded the highest mean grain yield (7045 kg/ha) and weed reduction efficiency (86%), closely followed by TOP1 (6637 kg/ha, 79%). FP lagged behind in both yield (6247 kg/ha) and weed suppression (64%). The correlation between reduced total weed dry matter and higher yield indicates the critical role of early and sustained weed control in improving DSR productivity.

Overall, both technology options (TOP1 and TOP2) were agronomically and economically superior to FP, with TOP2 emerging as the most effective treatment. The improved weed control efficiency, coupled with better crop establishment, higher productive tillers, and greater grain yield, underscores the potential of these technologies for sustainable DSR production, especially in regions facing labor shortages and escalating weed issues (Rao et al., 2017; Chauhan *et al.*, 2021).

Table 5. Summary Statistics

Parameter	**TOP1**	**TOP2**	**FP**
Mean Grain Yield (kg/ha)	6637	**7045**	6247
Mean Net Returns (₹/ha)	1,11,452	**1,18,268**	98,290
Mean B:C Ratio	3.71	3.70	3.17
Mean Total Weed Dry Matter (15 DAS) (g/m²)	11.3	**6.6**	23.9
Weed Reduction Efficiency (%)	79	**86**	64

CONCLUSION

The results of on-farm research demonstrated that the sequential application of Triafamone 20% + Ethoxysulfuron 10% WG (15–20 DAS) followed by Fenoxaprop-*p*-ethyl (40–45 DAS) was highly effective in reducing weed density and enhancing yield and profitability in dry-DSR under Central Telangana Zone. Adoption of this technology can minimize weed infestation and provide substantial monetary benefits to farmers practicing DSR.

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