



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
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NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(10): 947-950
Received: 09-08-2025
Accepted: 15-09-2025

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Comparative performance of post-emergence herbicides in transplanted finger millet (*Eleusine coracana* L.)

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DOI: <https://www.doi.org/10.33545/2618060X.2025.v8.i10m.4092>

Abstract

This field experiment on weed management practices was conducted during *rabi*, 2024-25 at wetland farm of S.V. Agricultural College, Tirupati, to evaluate the best post-emergence herbicides in transplanted finger millet. The experiment was laid out in a randomized block design, with ten weed management practices and replicated thrice. Among all the weed management practices, lower weed density and dry weight with higher weed control efficiency and weed control index was recorded with hand weeding twice at 15 and 30 DAT, which was on par with post-emergence application of penoxsulam 21.7% SC @ 20 g ha⁻¹. The next best treatment was post-emergence application of 2,4-D sodium salt 800 g ha⁻¹, which was at par with post-emergence application of triafamone + ethoxysulfuron 30 g ha⁻¹ and post-emergence application of bispyribac-sodium + pyrazosulfuron ethyl 52.5 g ha⁻¹.

Keywords: Finger millet, penoxsulam, post-emergence herbicides, weed control efficiency

Introduction

Millets are energy-dense, protein and mineral-rich grains that contribute significantly to nutritional security. They help to address nutrient deficiencies and manage dietary disorders, making them valuable for food and health. Finger millet (*Eleusine coracana* L.), commonly known as ragi, is a major millet in India, accounting for about 85% of national production. It is predominantly cultivated in South India under rainfed conditions due to its climate resilience, ability to tolerate poor soils and multiple uses as food and fodder. In 2022-23, ragi was grown in 1.16 m ha, with a production of 1.69 m t and productivity of 1450 kg ha⁻¹. Despite its advantages, productivity is constrained by weed infestation. Since finger millet exhibits slow early growth, weeds will dominate and compete for nutrients, water and light, causing 35-75% yield loss depending on severity. Traditionally, mechanical and cultural practices are used for weed control in India, but these demand high labor, cost and time, which becomes challenging during *kharif* and *rabi* when labor shortages and high wages prevail. Herbicides, therefore, play a critical role in improving weed management. Pre-emergence herbicides applied soon after sowing suppress early weeds but fail to control later flushes that emerge after 30 DAS. Hence, post-emergence herbicides become essential for season-long control.

Recent advances have introduced new-generation herbicides effective at low doses, offering broad-spectrum weed control, shorter persistence and lower toxicity. Ready-mix formulations combining herbicides with different modes of action (e.g., penoxsulam + cyhalofop-butyl, triafamone + ethoxysulfuron) are gaining popularity for effectively targeting grasses, sedges and broadleaved weeds. These not only improve crop growth and yield but also reduce overall production costs.

Materials and Methods

A field experiment was conducted during *Rabi* (winter season), 2024-25 at wetland farm of S.V. Agricultural College, Tirupati, which was geographically situated at 13.3°N latitude and 79.2°E longitude, with an altitude of 182.9 m above mean sea level, which falls under Southern Agro-Climatic Zone of Andhra Pradesh. The soil of experimental site was sandy clay loam in texture and neutral in reaction, low in available nitrogen, medium in organic carbon and potassium and

high in available phosphorus. The total rainfall received during crop period was 453.0 mm with 20 rainy days. The experiment was laid out in a randomized block design with ten treatments and replicated thrice. The treatments consisted of early post-emergence application of bensulfuron methyl + pretilachlor 500 g ha⁻¹ (T₁), early post-emergence application of pretilachlor + pyrazosulfuron ethyl 460 g ha⁻¹ (T₂), post-emergence application of bispyribac-sodium + pyrazosulfuron ethyl 52.5 g ha⁻¹ (T₃), post-emergence application of penoxsulam + cyhalofop-butyl 67.6 g ha⁻¹ (T₄), post-emergence application of triafamone + ethoxysulfuron 30 g ha⁻¹ (T₅), post-emergence application of fenoxaprop-p-ethyl 42 g ha⁻¹ (T₆), post-emergence application of penoxsulam 20 g ha⁻¹ (T₇), post-emergence application of 2,4-D sodium salt 800 g ha⁻¹ (T₈), hand weeding twice at 15 and 30 DAT (T₉), and weedy check (T₁₀). Finger millet was transplanted at 22.5 cm x 10 cm spacing on 23th November, 2024. Early post-emergence and post-emergence herbicides were applied to transplanted finger millet at 13 DAT and 20 DAT respectively by using power operated knapsack sprayer fitted with flat fan nozzle and with a spray volume of 500 L ha⁻¹. The crop was fertilized with 60 kg N, 30 kg P₂O₅ and 30 kg K₂O ha⁻¹. The rest of the package of practices were adopted as per the recommendations of the Acharya N.G. Ranga Agricultural University. Weed density and biomass were recorded randomly at 20 & 40 DAT with the help of 0.25 m² quadrat and subjected to square root transformation ($\sqrt{x+0.5}$) to normalize their distribution as suggested by Gomez and Gomez (1984)^[3]. Weed control efficiency of different weed management practices imposed in finger millet was calculated based on weed dry matter with the following formula and expressed as per centage.

$$WCE = \frac{DM_c - DM_t}{DM_c} \times 100$$

WCE: Weed Control Efficiency (%)

DM_c: Dry matter of weeds in unweeded check (Control)

DM_t: Dry matter of weeds in treatment plot

Weed index for different weed management practices was calculated based on the seed yield as per formula suggested by Gill and Kumar (1969)^[2].

$$WI (\%) = \frac{X-Y}{X} \times 100$$

X= Yield from minimum weed competition plot (kg ha⁻¹)

Y= Yield from treatment for which WI has to be worked out (kg ha⁻¹)

Results and Discussion

Weed flora

Weed flora of the experimental field belongs to ten taxonomic families of which predominant weed species were *Dactyloctenium aegyptium* and *Digitaria sanguinalis* among grasses; *Cyperus rotundus* a sedge; *Boerhavia erecta*, *Commelina benghalensis* and *Euphorbia hirta* among broadleaved weeds.

Weed density, dry weight and weed control efficiency

All the weed management practices significantly influenced the weed density, biomass and weed control efficiency at 20 DAT and 40 DAT of finger millet (Table 1). Among the weed management practices investigated, hand weeding twice at 15 and 30 DAT (T₉) registered significantly lower weed density, biomass and weed control efficiency at 20 & 40 DAT. Hand weeding at 15 DAT effectively reduced the density of grasses, sedges and broadleaved weeds as well as the total weed population. Early post-emergence application of pretilachlor + pyrazosulfuron ethyl 460 g ha⁻¹ (T₂), was the next superior treatment in recording lowest density of total weeds followed by early post-emergence application of bensulfuron methyl + pretilachlor 500 g ha⁻¹ (T₁), with significant disparity. These results are in line with Ashok *et al.* (2024)^[1] and Ramadevi *et al.* (2021)^[6]. At 40 DAT after hand weeding twice, next best weed management practice was post-emergence application of penoxsulam 20 g ha⁻¹ (T₇), which was on par with post-emergence application of triafamone + ethoxysulfuron 30 g ha⁻¹ (T₅), but the later treatment was on par with post-emergence application of bispyribac-sodium + pyrazosulfuron ethyl 52.5 g ha⁻¹ (T₃) and post-emergence application of fenoxaprop-p-ethyl 42 g ha⁻¹ (T₆). These results were in line with Roy *et al.* (2022)^[7] and Srinithan *et al.* (2021)^[9]. Penoxsulam, triafamone, ethoxysulfuron, pyrazosulfuron ethyl all these herbicides were found effective in controlling wide range of weed species mainly perennial sedges by inhibiting ALS enzyme, which was responsible for biosynthesis of branched chain amino acids.

Yield attributes and yield

The results as depicted in Table 2 revealed that different weed control measures significantly improved the growth, yield attributes and yield of transplanted finger millet. Growth parameters of finger millet, viz., plant height, leaf area index and dry matter production and yield attributes, viz., productive tillers m⁻², weight of ear head and grain and stover yield were significantly higher with hand weeding twice at 15 and 30 DAT (T₉), which was at par with post-emergence application of penoxsulam 20 g ha⁻¹ (T₇). This could be mainly due to the reduced weed density and growth thus providing weed free environment during initial and later stages of crop growth, due to with all the above and below ground resources were optimally utilized by the crop plants for better vegetative growth and reproductive potential that reflected as noticed with increased growth parameters, yield attributes and yield as reported by Shubhashree *et al.* (2023)^[8].

Phytotoxicity was observed in post-emergence application of bispyribac-sodium + pyrazosulfuron ethyl 52.5 g ha⁻¹ (T₃) and post-emergence application of triafamone + ethoxysulfuron 30 g ha⁻¹ (T₅) with phytotoxicity rating '1' resulted in reduced growth parameters, eventually lower yield attributes and yield. Similar views were also endorsed by Patel *et al.* (2024)^[5]. Post-emergence application of penoxsulam 1.02% + cyhalofop-butyl 5.1% OD @ 67.6 g ha⁻¹ (T₄) and post-emergence application of fenoxaprop-p-ethyl 6.7% EC @ 42 g ha⁻¹ (T₆) also showed phytotoxicity with a rating scale 8 and crop was not recovered. Similar views were also endorsed by Pandey *et al.* (2018)^[4].

Table 1: Weed dynamics of transplanted finger millet influenced by various weed management practices during 2024-25

Treatments	Weed density (No. m ⁻²)*		Weed dry weight (g m ⁻²)*		Weed control efficiency (%)		Weed index
	20 DAT	40 DAT	20 DAT	40 DAT	20 DAT	40 DAT	At harvest
Early post-emergence (EPoE) application of bensulfuron methyl 0.6% + pretilachlor 6.0% GR @ 500 g ha ⁻¹ (T ₁)	10.92 (118.67)	8.89 (78.67)	4.57 (20.35)	4.50 (19.95)	13.6	71.4	31.56
EPoE application of pretilachlor 6.0% + pyrazosulfuron ethyl 0.15% GR @ 460 g ha ⁻¹ (T ₂)	10.22 (104.00)	8.80 (77.33)	4.51 (19.84)	4.08 (16.17)	15.5	72.4	28.54
Post-emergence (PoE) application of bispyribac-sodium 20% + pyrazosulfuron ethyl 15% WDG @ 52.5 g ha ⁻¹ (T ₃)	11.54 (133.33)	6.44 (41.00)	4.89 (23.40)	3.21 (9.83)	-	83.2	43.24
PoE application of penoxsulam 1.02% + cyhalofop-butyl 5.1% OD @ 67.6 g ha ⁻¹ (T ₄)	11.20 (125.00)	7.38 (53.90)	4.90 (23.62)	3.47 (11.55)	-	80.2	83.26
PoE application of triafamone 20% + ethoxysulfuron 10% WG @ 30 g ha ⁻¹ (T ₅)	11.29 (127.00)	6.23 (38.33)	4.92 (23.74)	3.10 (9.17)	-	84.4	42.75
PoE application of fenoxaprop-p-ethyl 6.7% EC @ 42 g ha ⁻¹ (T ₆)	11.42 (130.00)	6.75 (45.33)	4.85 (23.08)	3.31 (10.49)	-	82.0	86.12
PoE application of penoxsulam 21.7% SC @ 20 g ha ⁻¹ (T ₇)	11.39 (129.33)	5.73 (32.33)	4.91 (23.70)	2.81 (7.49)	-	87.3	5.97
PoE application of 2,4-D sodium salt 80% WP @ 800 g ha ⁻¹ (T ₈)	11.50 (131.67)	8.07 (64.67)	4.92 (23.80)	4.19 (17.17)	-	70.5	17.17
Hand weeding twice at 15 and 30 DAT (T ₉)	5.92 (34.67)	3.39 (11.00)	1.33 (1.28)	1.38 (1.43)	94.5	97.5	0
Weedy check (T ₁₀)	11.51 (132.00)	13.07 (170.33)	4.90 (23.60)	7.68 (58.42)	0.0	0.0	54.27
SEm ±	0.211	0.208	0.137	0.151	2.11	1.70	1.72
CD (P=0.05)	0.63	0.62	0.41	0.45	6.3	5.04	5.20

* Data in parentheses are original values, which are square root transformed and analyzed statistically.

Table 2: Growth, yield attributes and yield of transplanted finger millet as influenced by various weed management practices during 2024-25

Treatments	Plant height (cm)	LAI	Productive tillers (No. m ⁻²)	Dry matter production (kg ha ⁻¹)	Weight of ear head (g)	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)
Early post-emergence (EPoE) application of bensulfuron methyl 0.6% + pretilachlor 6.0% GR @ 500 g ha ⁻¹ (T ₁)	74.9	3.29	106	6013	5.74	2110	3075
EPoE application of pretilachlor 6.0% + pyrazosulfuron ethyl 0.15% GR @ 460 g ha ⁻¹ (T ₂)	76.4	3.47	110	6098	5.90	2203	3154
Post-emergence (PoE) application of bispyribac-sodium 20% + pyrazosulfuron ethyl 15% WDG @ 52.5 g ha ⁻¹ (T ₃)	56.8	1.29	79	4405	4.42	1750	2640
PoE application of penoxsulam 1.02% + cyhalofop-butyl 5.1% OD @ 67.6 g ha ⁻¹ (T ₄)	32.9	0.71	35	1738	2.45	516	1114
PoE application of triafamone 20% + ethoxysulfuron 10% WG @ 30 g ha ⁻¹ (T ₅)	59.2	1.38	80	4443	4.54	1765	2664
PoE application of fenoxaprop-p-ethyl 6.7% EC @ 42 g ha ⁻¹ (T ₆)	32.1	0.70	28	1425	2.25	428	950
PoE application of penoxsulam 21.7% SC @ 20 g ha ⁻¹ (T ₇)	84.8	5.14	139	7560	8.06	2899	4058
PoE application of 2,4-D sodium salt 80% WP @ 800 g ha ⁻¹ (T ₈)	80.4	4.84	124	6830	7.10	2553	3534
Hand weeding twice at 15 and 30 DAT (T ₉)	86.5	5.31	143	7589	8.10	3083	4316
Weedy check (T ₁₀)	68.8	2.09	66	5263	3.42	1410	2260
S.Em ±	1.13	0.065	3.6	242.00	0.302	113.8	126.6
CD (P=0.05)	3.3	0.19	11	719	0.89	338	376

Conclusions

In conclusion, the present study has revealed that, post-emergence application of penoxsulam 20 g ha⁻¹ (T₇) and post-emergence application of 2,4-D sodium salt 800 g ha⁻¹ (T₈) were considered to be the most effective weed management practices to control diversified weed flora and enhancing productivity in transplanted finger millet.

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