



RESEARCH ARTICLE

Influence of integrated weed and nutrient management on weeds and productivity of finger millet

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ABSTRACT

A field experiment was conducted to evaluate the performance of integrated weed and nutrient management treatments on weed dynamics, crop growth, yield and economics of finger millet under rainfed agroecosystem of eastern India. Experiment was laid out in factorial randomized block design with three replications. Four weed management treatments were tested, including weedy check, hand weeding twice at 25 and 45 days after seeding (DAS), pre-emergence application (PE) of pyrazosulfuron-ethyl 20 g/ha followed by (*fb*) hand weeding (HW) once at 30 DAS, pyrazosulfuron-ethyl 20 g/ha PE *fb* post-emergence application (PoE) of 2,4-D 0.50 kg/ha at 25 DAS in combination with four integrated nutrient management (INM) treatments comprising of 100% recommended dose of nitrogen (RDN), 75% RDN (inorganic nitrogen)+25% RDN as farm yard manure (FYM), 50% RDN (IN) +50% RDN (FYM), 50% RDN (IN)+25% RDN (FYM)+25% RDN vermicompost (VC). Among the treatments, pyrazosulfuron-ethyl 20 g/ha *fb* HW once at 30 DAS proved the most effective in managing the weeds throughout critical crop growth period. Application of 100 % RDN gave significantly higher crop grain and straw yields. Economic analysis indicated that HW twice at 25 and 45 DAS had significantly the highest gross, net returns, B:C ratio, production and economic efficiency as compared to weedy check and pyrazosulfuron 20 g/ha PE *fb* 2,4-D 0.50 kg/ha PoE at 25 DAS. Significantly higher gross, net returns, B:C ratio, production and economic efficiency were observed with 100% RDN.

Keywords: 2,4-D, Economics, Finger millet, Nutrient management, Pyrazosulfuron, Rainfed agro-ecosystem, Weed management

INTRODUCTION

Finger millet (*Eleusine coracana* L.), commonly known as ragi, is a vital minor millet crop grown extensively in rainfed agro-ecosystems across India, particularly in the eastern, central and southern regions. It is valued for its nutritional quality, resilience to abiotic stresses and adaptability to low-input systems, making it a staple for food and fodder in resource-poor farming communities (Kumar *et al.* 2019). Finger millet is rich in Ca, dietary fiber, essential amino acids, and phenolic compounds, which contribute to food security as well as

nutritional well-being of millions of rural households in semi-arid and dryland conditions across the country (Kumar *et al.* 2021a, b). Its importance is underscored by its cultivation on significant acreage with considerable production volumes though crop productivity levels remain low compared to potential yields due to multiple biotic/abiotic constraints, among which weed infestation and nutrient limitations are key yield-limiting factors in rainfed production system (Kumar *et al.* 2023a, b). In rainfed agro-ecosystem, finger millet often faces the adverse growing conditions such as erratic rainfall distribution, nutrient-poor soils and intense biotic pressures like weeds. Crop exhibits slow initial crop growth, which prolong crop vulnerable window to weed competition during early growth period (Rao 2021). Weeds exploit this early growth lag phase to establish and compete aggressively with crop for essential growth resources, *viz.* moisture, nutrients, space, and light particularly during the critical period 20 to 45 days after sowing (DAS). It was found that heavy infestation by weed particularly the grassy weeds such as: *Brachiaria ramosa*, *Digitaria*

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sanguinalis; sedges like *Cyperus rotundus* and broad-leaved weeds (BLW) such as: *Phyllanthus niruri*, *Amaranthus viridis*, *Caesulia axillaris*, *Portulaca oleracea*, *Trianthema portulacastrum*, poses serious constraint of finger millet production. Competitive interference from weeds can cause up to 70% crop yield loss depending on species and density of weed flora, and management practices (Rao 2021, Kumar *et al.* 2022a,b,c). Several studies demonstrated that pre-emergence herbicide applications and timely intercultural operations such as hand weeding/mechanical hoeing can significantly reduce weeds and improve finger millet yield by reducing nutrient removal by weeds and improving crop nutrient uptake (Kumar *et al.* 2017). This underlines synergistic relationship between weed management and nutrient dynamics in crop production, well-managed weeds allow crops to utilize available nutrients more efficiently, improving yield component and economic returns (Rameshraddy *et al.* 2017, Nayak *et al.* 2025). Integrated nutrient management (INM) has emerged as a sustainable agronomic approach to enhance nutrient use, build soil fertility and improve crop performance in rainfed agro-ecosystems. Thus, the present study was undertaken with an objective to identify the effective integrated nutrient and weed management options to manage weeds and improve finger millet productivity.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* 2023 and 2024 at ICAR Research Complex for Eastern Region, Patna, Bihar, India (25°30'N, 85°15'E, 52 m above mean sea levels). Precipitation was recorded during crop growing season was 891.1 and 649.1 mm during 2023 and 2024, respectively. Consequently, during the second year of experimentation, amount of precipitation was unequally distributed, fluctuated variably high during crop growing period compared to first year where equal distribution of precipitation was occurred. Average maximum and minimum temperature were observed 35.1, 26.3 and 34.8, 27.5 °C during crop growth period of 2023 and 2024, respectively. Soil of experimental site was loamy in texture (50.4, 35 and 14.6% sand, silt and clay) with pH of 7.6, EC of 0.14 dS/m, soil organic carbon (SOC) content of 6.5 g/kg, KMnO₄ oxidizable N of 67.4 mg/kg, Olsen P 22.5 mg/kg, NH₄OAc exchangeable K 77.8 mg/kg and DTPA-extractable Zn 0.62 mg/kg (0-15 cm soil). This field trial comprised of 4-weed management treatments, *viz.* weedy check, hand weeding twice at 25 and 45 days after seeding (DAS), pre-emergence application (PE) of pyrazosulfuron-ethyl 20 g/ha followed by

(*fb*) hand weeding (HW) once at 30 DAS, pyrazosulfuron-ethyl 20 g/ha PE *fb* post-emergence application (PoE) of 2,4-D 0.50 kg/ha at 25 DAS and nutrient management, *viz.* 100% of nitrogen (RDN), 75% RDN (inorganic nitrogen) + 25% RDN as farmyard manure (FYM), 50% RDN (IN) + 50% RDN (FYM), 50% RDN (IN) + 25% RDN (FYM) + 25% RDN vermicompost (VC). A factorial randomized block design with three replications was used.

The standard agronomic management practices were followed as per crop requirement. Gross plot size of the experimental plot was 5.0 m×4.0 m with spacing of 25 cm×5 cm. To control the initial weed flushes the pre-emergence herbicides were applied as per treatments using 500 liters water/ha with help of knap-sack sprayer, fitted with flat-fan nozzle. Hand-hoeing (HW) was also done at 25 and 45 DAS and intra-row weeds were removed by the hand-weeding simultaneously recommended dose of P and K i.e. 40 kg/ha each was applied in all treatment through diammonium phosphate (DAP) and muriate of potash (MOP), respectively. The N (60 kg/ha) was applied as per treatment using urea after subtracting N supplied through DAP as basal. Further, N was applied in 2-equal splits, 50% as basal and remaining at 35 DAS. Gross plot size (20 m²) was harvested separately for estimation of grain and straw/stover yields. After harvesting, threshing was done and crop yield was recorded. The crop yield was further adjusted at 12% moisture content. Weed density and biomass were recorded at 20 and 40 DAS using a quadrat (0.5 m × 0.5 m) placed randomly at 4-places in each plot. Weeds within each quadrat were uprooted, separated species wise and counted. Weed samples were oven dried before weighing at 70 °C till to constant weight was achieved. The relative abundance of weed was calculated by following formula:

$$\text{Relative abundance (\%)} = \frac{\text{Total number of individual weed species}}{\text{Total number of individual of all weed species}} \times 100$$

Weed control efficiency of each treatment was computed by using the following formula.

$$\text{Weed control efficiency (\%)} = \frac{\text{DMC} - \text{DMT}}{\text{DMC}} \times 100$$

Where, DMC= Weed biomass in weedy check plot; DMT= Weed biomass in treated plot

Weed index is a measure of crop yield loss accrued across treatments in comparison to a weed free plot adopted in an experiment. Following formula was used in calculating weed index.

$$\text{Weed index (\%)} = \frac{X - Y}{Y} \times 100$$

Where, X=Crop yield in weed free plots;
Y=Crop yield in the treated plot

Data on weed counts were subjected to square root transformation ($\sqrt{x+0.5}$) before statistical analysis to normalize their distribution. All recorded data were analyzed with the help of analysis of variance (ANOVA) technique using Indian NARS Statistical Computing Portal. Least significant difference test (LSD) was used for comparison of treatment means at 5% level of significance ($p=0.05$).

RESULTS AND DISCUSSION

Effect on weeds

At 20 DAS relative abundance of weed flora/ diversity in finger millet was significantly affected by the weed management and INM (Table 1). Among the weed management treatments, weedy check recorded the highest relative abundance of weeds dominated mainly by *Brachiaria ramosa* (53.7%), followed by *Trianthema portulacastrum* (14.4%) and *Cyperus rotundus* (11.5%). This indicates severe weed infestation in absence of control measures, with grassy weed being predominant during early crop growth. Hand weeding twice at 25 and 45 DAS significantly reduced dominance of *Brachiaria ramosa* (36.1%) as compared to weedy check; however, higher proportions of *Trianthema portulacastrum* (22.9%) and other weeds (7.71%)

were also observed, suggesting partial control and possible weed regeneration between weeding operations. Pyrazosulfuron-ethyl 20 g/ha PE *fb* HW once at 30 DAS had significantly reduced the relative abundance of *Digitaria sanguinalis* (3.82%) and *Trianthema portulacastrum* (0.86%). However, *Brachiaria ramosa* remained dominant (43.9%). Most effective treatment was pyrazosulfuron-ethyl 20 g/ha PE *fb*2, 4-D 0.50 kg/ha PoE at 25 DAS, which had resulted in complete elimination of several BLWs, viz. *A. viridis*, *Caesulia axillaris*, *Portulaca oleracea* and *Trianthema portulacastrum*. However, higher relative abundance of *Brachiaria ramosa* (42.7%) and *Cyperus rotundus* (21.9%) (Table 1).

The INM had positive influenced on weed flora composition in finger millet during the experimentation. The 100% RDN caused relatively lower abundance of *Brachiaria ramosa* (42.4%) and moderate presence of *Trianthema portulacastrum* (10.3%). 75% RDN inorganic nitrogen (IN) + 25% RDN (FYM) and 50% RDN (IN) + 50% RDN farmyard manure (FYM) had higher relative abundance of *Brachiaria ramosa* (45.5 and 45.7%, respectively), indicating that addition of organic sources favored grassy weed proliferation during early crop stages. Integrated application of 50% RDN (IN) + 25% RDN (FYM) + 25% RDN resulted in comparatively balanced weed flora with reduced dominance of grasses and moderate distribution of BLWs, suggesting more uniform nutrient availability that supported crop competitiveness against weed.

Table 1. Effect of weed management and integrated nutrient management treatments on relative abundance (%) of weeds in finger millet at 20 and 40 DAS (mean data of 2-years)

Treatment*	Weed management					Nutrient management				
	Weedy check	Hand weeding (HW) twice at 25 and 45 DAS	Pyrazosulfuron 20 g/ha PE <i>fb</i> HW once at 30 DAS	Pyrazosulfuron 20 g/ha PE <i>fb</i> 2,4-D 0.50 kg/ha PoE at 25 DAS	LSD (p=0.05)	100% RDN	75% RDN (IN)+25% RDN (FYM)	50% RDN (IN)+50% RDN (FYM)	50% RDN (IN)+25% RDN (FYM)+25% RDN (VC)	LSD (p=0.05)
<i>Brachiaria ramosa</i>	20 DAS 53.7	36.1	43.9	42.7	7.4	42.4	45.8	45.1	43.1	7.4
	40 DAS 23.1	32	21.9	21.2	7.6	28.6	23.2	23.3	23.1	7.6
<i>Cyperus rotundus</i>	20 DAS 11.5	14.9	25.4	21.8	6.6	21.3	16.3	18.2	18	6.59
	40 DAS 26.2	31.2	28.7	31.7	9.9	32.9	33.1	24.4	27.3	9.9
<i>Digitaria sanguinalis</i>	20 DAS 11.4	12.4	3.8	0.6	2.9	8.9	5.3	7.4	6.7	2.9
	40 DAS 20.9	22.1	25.9	24.3	12.6	18.7	23.2	23.9	27.5	12.6
<i>Phyllanthus niruri</i>	20 DAS 2.5	3.8	5.5	5.2	4.2	5.6	2.7	3.3	5.3	4.2
	40 DAS 6.4	0.4	0.6	0.8	2.3	0.9	1.8	3.1	2.3	2.3
<i>Amaranthus viridis</i>	20 DAS 1.6	1.1	6.5	0.0	2.9	0.7	4.0	2.5	1.9	2.9
	40 DAS 3.1	0.0	3.2	0.8	3.4	1.2	1.9	3.9	0.0	3.4
<i>Caesulia axillaris</i>	20 DAS 0.9	0.4	1.3	0	1.7	0.5	1.6	0.1	0.4	1.7
	40 DAS 0.2	0.0	0.0	0.8	1.4	0.0	0.2	0.8	0.0	1.43
<i>Portulaca oleracea</i>	20 DAS 0.8	0.6	0.0	0.0	0.7	0.5	0.2	0.5	0.1	0.7
	40 DAS 0.4	0.0	0.0	0.8	1.6	0.0	0.4	0.8	0.0	1.6
<i>Trianthema portulacastrum</i>	20 DAS 14.4	23.0	0.9	0.0	3.9	10.3	9.4	7.7	10.8	3.9
	40 DAS 7.9	0.0	0.0	0.8	3.0	2.6	1.6	3.2	1.2	3.0
Other weeds	20 DAS 3.2	7.7	12.7	29.6	4.7	9.7	14.5	15.2	13.8	4.7
	40 DAS 11.9	14.3	19.6	18.8	7.7	15.0	14.5	16.5	18.7	7.7

*PE = pre-emergence application; PoE = post-emergence application; *fb* = followed by, FYM = farm yard manure; RDN = recommended dose of nitrogen, VC= vermicompost, IN=inorganic nitrogen; DAS = days after seeding

Relative abundance of weed flora in finger millet at 40 DAS was significantly altered by different weed management and INM in rainfed agro-ecosystem of eastern India (Table 1). Hand weeding twice at 25 and 45 DAS markedly altered the composition by suppressing most BLWs, resulting in negligible abundance of *Phyllanthus niruri*, *Amaranthus viridis*, *Caesulia axillaris*, *Portulaca oleracea* and *T. portulacastrum*. However, grassy weeds remained dominant; with higher relative abundance of *Brachiaria ramosa* (32%), *Cyperus rotundus* (31.2%) and *Digitaria sanguinalis* (22.1%) significantly lowered relative abundance over weedy check. *Cyperus rotundus* (26.1%), *Brachiaria ramosa* (23.1%) and *Digitaria sanguinalis* (21%), along with appreciable presence of BLWs i.e. *Trianthema portulacastrum* (7.86%) and *Phyllanthus niruri* (6.4%). Pyrazosulfuron-ethyl 20 g/ha PE fb HW once at 30 DAS effectively reduced the relative abundance of BLWs, particularly *Phyllanthus niruri* (0.56%) and completely suppressed *Caesulia axillaris*, *Portulaca oleracea* and *T. portulacastrum*. Nevertheless, grassy weeds, viz. *Digitaria sanguinalis* (25.9%) and *Cyperus rotundus* (28.7%) continued to dominate weed flora. Integration of pyrazosulfuron-ethyl PE fb 2, 4-D 0.5 kg/ha PoE at 25 DAS resulted in comparatively uniform reduction of grassy and BLWs. Although *Cyperus rotundus* (31.7%) and *Digitaria sanguinalis* (24.3%) remained predominant, relative abundance of BLWs reduced to less (<1) indicating effectiveness of sequential herbicide application.

Nutrient management also exerted a notable influence on weed composition. Application of 100% RDN favored dominance of *Cyperus rotundus* (32.9%) and *Brachiaria ramosa* (28.6%), while BLWs occurred in negligible. Substitution of inorganic nitrogen with organic sources increased relative abundance of certain BLWs. Treatment 50% RDN (IN) + 50% RDN (FYM) had higher proportion of *Phyllanthus niruri* (3.1%), *Amaranthus viridis* (3.9%) and *T. portulacastrum* (3.2%), indicating a more diversified weed flora. Similarly, application of 50% RDN (IN) + 25% RDN (FYM) + 25% RDN vermicompost (VC) resulted in increased dominance of *D. sanguinalis* (27.5%) higher proportion of another weed (18.7%).

Weed species, total weed density, weed dry biomass, WCE and weed index

Species wise weed composition, total weed density and dry biomass of finger millet at 20 DAS were significantly reduced by different weed

management and INM in rainfed agro-ecosystem of eastern India (Table 2). Weedy check was found the maximum density of major grassy, sedges and BLWs, particularly *Brachiaria ramosa*, *Cyperus rotundus* and *Digitaria sanguinalis*, along with higher populations of *Phyllanthus niruri* and *Trianthema portulacastrum*. Consequently, this treatment was registered the highest total weed density and weed dry-biomass, indicating severe weed competition under unchecked conditions (Patil *et.al.* 2013). The HW twice at 25 and 45 DAS significantly reduced the density of BLW compared to weedy check, particularly *P. niruri*, *Amaranthus viridis*, *Caesulia axillaris*, *Portulaca oleracea* and *T. portulacastrum*. However, grassy weeds such as *Brachiaria ramosa* and sedge like *Cyperus rotundus* remained relatively high. This treatment resulted in a moderate reduction in total weed density and weed dry biomass over weedy check. Pyrazosulfuron-ethyl 20 g/ha PE fb HW once at 30 DAS proved more effective in suppressing both grassy and BLWs as it significantly reduced density of *B. ramosa* and *D. sanguinalis*, along with marked suppression of BLWs. As a result, total weed density and dry biomass were significantly lower than other treatments. Integration of pyrazosulfuron-ethyl 20 g/ha PE fb 2, 4-D 0.50 kg/ha PoE at 25 DAS recorded the lowest total weed density and significantly reduced weed dry biomass. This treatment effectively controlled both grassy and BLWs, indicating an advantage of sequential herbicide application under the rainfed conditions.

Among the nutrient management practices, application of 100% RDN and 75% RDN (IN) + 25% RDN (FYM) recorded comparatively higher densities of grassy weed, especially *B. ramosa* and *C. rotundus*, resulting in higher total weed density and weed dry biomass. In contrast, greater substitution of inorganic N with organic sources significantly reduced weed pressure. Application of 50% RDN (IN) + 50% RDN (FYM) recorded the lowest total weed density and weed dry biomass, followed by 50% RDN (IN) + 25% RDN (FYM) + 25% RDN (VC), which also resulted in significantly lower weed density and weed biomass.

Weed species composition, total weed density/biomass of finger millet at 40 DAS were significantly reduced by different weed management and INM options (Table 2). Weedy check recorded the highest density of major grassy and BLWs, particularly *Brachiaria ramosa*, *Cyperus rotundus* and *Digitaria sanguinalis*, along with higher density of *Phyllanthus niruri* and *Trianthema portulacastrum*. Weedy check

registered the maximum total weed density and weed dry-biomass, indicating severe weed competition under unchecked conditions (Patil *et.al.* 2013). 2-HW at 25 and 45 DAS significantly reduced density of BLW compared to weedy check, particularly *P. niruri*, *Amaranthus viridis*, *Caesulia axillaris*, *Portulaca oleracea* and *T. portulacastrum*. However, grassy weeds such as *Brachiaria ramosa* and *Cyperus rotundus* remained relatively higher with a moderate reduction in total weed density and weed dry biomass over weedy check. Pyrazosulfuron-ethyl 20 g/ha (PE) *fb* 1-HW at 30 DAS proved more effective in suppressing both grassy and BLWs with significantly reduced density of *B. ramosa*, *C. rotundus* and *D. sanguinalis*, along with marked suppression of BLWs. As a result, total weed density, dry biomass at 20 and 40 DAS and weed index were significantly lower than HW twice and weedy check. Integration of pyrazosulfuron-ethyl 20 g/ha PE *fb* 2,4-D 0.50 kg/ha PoE at 25 DAS recorded the lowest total weed density and significantly reduced weed dry biomass and higher weed control efficiency, which was at par with pyrazosulfuron-ethyl 20 g/ha PE *fb* HW once at 30 DAS. This treatment effectively

controlled both grassy and BLWs, indicating an advantage of sequential herbicide application under the rainfed conditions.

Among the nutrient management practices, application of 100% RDN and 75% RDN (IN)+25% RDN (FYM) recorded comparatively higher densities of grassy weed, especially *B. ramosa* and *C. rotundus*, resulting in higher total weed density and weed dry biomass. In contrast, greater substitution of inorganic N with organic sources significantly reduced weed pressure.

Effect on finger millet yield and economics

Weed management practices significantly influenced finger millet grain, straw yield, productivity and economic returns of finger millet (Table 3). Weedy check has recorded the lowest grain yield, straw yield, gross returns, net returns, crop productivity and crop profitability, indicating severe yield and economic losses due to unchecked weed competition. Among weed control treatments, twice HW at 25 and 45 DAS proved the most effective, producing the highest grain yield, straw yield, maximum gross returns, net returns, B-C ratio

Table 2. Effect of weed management and integrated nutrient management practices on weed density, dry-biomass, weed control efficiency and weed index in finger millet at 20 and 40 DAS (mean data of 2-years)

Treatment*		Weed management				LSD (p=0.05)	Nutrient management				LSD (p=0.05)
		W1	W2	W3	W4		N1	N2	N3	N4	
<i>Brachiaria ramosa</i>	20 DAS	13.8(194)	8.1(67.7)	6.3(40.0)	4.1(16.7)	1.23	7.8(70.3)	8.4(88.0)	8.1(82.3)	8.1(78.0)	1.23
	40 DAS	4.6(21.3)	5.3(27.7)	3.3(11.0)	3.2(10.7)	0.68	4.6(22.0)	4.3(19.0)	3.7(14.3)	3.8(15.3)	0.68
<i>Cyperus rotundus</i>	20 DAS	6.4(40.7)	5.1(25.7)	4.8(23.0)	2.9(8.3)	0.74	4.9(25.7)	4.6(22.7)	4.8(24.7)	4.8(24.7)	0.74
	40 DAS	5.1(26.0)	5.2(28.3)	3.7(13.7)	4.1(16.7)	1.04	4.7(23.3)	5.2(28.3)	3.8(14.7)	4.1(18.3)	1.04
<i>Digitaria sanguinalis</i>	20 DAS	6.3(40.0)	4.7(22.3)	1.7(3.7)	0.8(0.3)	0.73	3.7(20.0)	3.0(14.7)	3.4(16.7)	3.4(15.0)	0.73
	40 DAS	4.5(21.0)	4.3(19.7)	3.5(15.0)	3.3(11.3)	1.25	3.6(14.7)	4.5(21.3)	3.7(14.3)	3.9(16.7)	1.25
<i>Phyllanthus niruri</i>	20 DAS	2.9(9.3)	2.5(6.7)	2.1(5.0)	1.4(2.0)	1.01	2.2(5.3)	1.9(4.3)	2.3(6.3)	2.5(7.0)	1.01
	40 DAS	2.5(6.0)	0.8(0.3)	0.8(0.3)	0.8(0.3)	0.47	1.0(1.0)	1.4(2.3)	1.3(2.0)	1.2(1.7)	0.47
<i>Amaranthus viridis</i>	20 DAS	2.3(6.0)	1.4(2.0)	2.2(6.0)	0.7(0.0)	0.89	1.2(1.7)	2.0(5.7)	1.6(3.3)	1.7(3.3)	0.89
	40 DAS	1.6(3.0)	0.7(0.0)	1.2(1.7)	0.8(0.3)	0.62	1.0(1.0)	1.2(1.7)	1.4(2.3)	0.7(0.0)	0.62
<i>Caesulia axillaris</i>	20 DAS	1.7(3.3)	1.0(1.0)	1.1(1.3)	0.7(0.0)	0.74	1.2(1.7)	1.4(2.7)	0.8(0.3)	1.0(1.0)	0.74
	40 DAS	0.8(0.3)	0.7(0.0)	0.7(0.0)	0.8(0.3)	0.28	0.7(0.0)	0.8(0.3)	0.8(0.3)	0.7(0.0)	0.28
<i>Portulaca oleracea</i>	20 DAS	1.6(2.7)	1.1(1.0)	0.7(0.0)	0.7(0.0)	0.54	1.1(1.3)	1.0(1.0)	1.1(1.0)	0.8(0.3)	0.54
	40 DAS	0.9(0.7)	0.7(0.0)	0.7(0.0)	0.8(0.3)	0.37	0.7(0.0)	0.9(0.7)	0.8(0.3)	0.7(0.0)	0.37
<i>Trianthema portulacastrum</i>	20 DAS	7.0(51.0)	6.5(42.7)	0.9(1.0)	0.7(0.0)	0.92	4.0(25.0)	3.8(23.7)	3.2(17.3)	4.1(28.7)	0.92
	40 DAS	2.6(7.3)	0.7(0.0)	0.7(0.0)	0.8(0.3)	0.53	1.3(2.3)	1.3(2.3)	1.2(2.0)	1.0(1.0)	0.53
Other weeds	20 DAS	3.5(11.7)	3.7(13.7)	3.5(11.7)	3.3(11.0)	0.5	3.1(9.7)	3.6(12.7)	3.6(13.0)	3.6(12.7)	0.5
	40 DAS	3.3(10.7)	3.4(12.0)	3.2(10.0)	2.9(8.7)	0.77	3.3(10.7)	3.2(10.7)	3.1(9.3)	3.2(10.7)	0.77
Total weed density (no./m ²)	20 DAS	18.9(359.0)	13.4(182.7)	9.6(91.7)	6.2(38.3)	1.21	11.9(161)	12.2(175)	11.8(165)	12.2(171)	1.21
	40 DAS	9.7(96.3)	9.3(88.0)	7.2(51.7)	6.9(49.0)	1.08	8.5(75.0)	9.1(86.7)	7.7(59.7)	7.9(63.7)	1.08
Total weed dry-biomass (g/m ²)	20 DAS	10.0(101)	6.5(42.7)	4.9(24.2)	3.3(10.5)	0.67	6.5(48.3)	6.3(48.2)	6.1(44.2)	5.9(37.9)	0.67
	40 DAS	4.50(19.9)	4.1(16.7)	3.3(10.3)	3.3(10.8)	0.43	3.9(15.6)	3.9(15.2)	3.7(13.6)	3.7(13.3)	0.43
Weed control efficiency (%)	20 DAS	0	34.1	49.9	66.7	5.2	35.2	42.5	41.6	31.3	5.2
	40 DAS	0.0	8.1	26.9	25.3	10.3	17.2	20.5	10.2	12.4	10.3
Weed index (%)		40.1	8.1	10.8	21.5	10.3	12.8	14.8	23.4	21.4	3.9

*Figures in parentheses are original values; data transformed to $\sqrt{x+0.5}$ transformations; *PE = pre-emergence application; PoE = post-emergence application; *fb* = followed by, FYM = farm yard manure; RDN = recommended dose of nitrogen, VC= vermicompost, IN=inorganic nitrogen; DAS = days after seeding; W1: Weedy check; W2: Hand weeding (HW) twice at 25 and 45 DAS; W3: Pyrazosulfuron 20 g/ha PE *fb* HW once at 30 DAS; W4: Pyrazosulfuron 20 g/ha PE *fb* 2,4-D 0.50 kg/ha PoE at 25 DAS; N1: 100% RDN; N2: 75% RDN (IN) +25% RDN (FYM); N3: 50% RDN (IN) + 50% RDN (FYM); N4: 50% RDN (IN)+25% RDN (FYM)+25% RDN (VC)

Table 3. Effect of weed management and integrated nutrient management practices on yield and economics of finger millet (mean data of 2-years)

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio	Crop productivity (kg/ha/day)	Crop profitability (Rs /ha/day)
<i>Weed management</i>								
Weedy check	1.38	1.50	36009*	51420	15412	1.45	10.3	115.0
Hand weeding (HW) twice at 25 and 45 DAS	2.29	2.13	50409	84433	34024	1.69	17.1	253.9
Pyrazosulfuron 20 g/ha PE <i>fb</i> HW once at 30 DAS	2.06	1.81	46409	75595	29186	1.65	15.3	217.8
Pyrazosulfuron 20 g/ha PE <i>fb</i> 2,4-D 0.50 kg/ha PoE at 25 DAS	1.81	1.68	45609	66643	21034	1.48	13.5	157.0
LSD (p=0.05)	0.08	0.14	178.6	2946	2946	0.07	0.62	21.99
<i>Nutrient management</i>								
100% RDN	2.25	2.23	41643	83091	41448	1.99	16.8	309.3
75% RDN (IN)+25% RDN (FYM)	2.07	2.09	42693	76629	33936	1.79	15.4	253.3
50% RDN (IN)+50% RDN (FYM)	1.50	1.08	43744	54558	10814	1.23	11.2	80.7
50% RDN (IN)+25% RDN (FYM)+25% RDN (VC)	1.73	1.71	50355	63813	13458	1.26	12.9	100.4
LSD (p=0.05)	0.08	0.14	178.6	2946	2946	0.07	0.62	21.99

Prices used for grain-Rs. 35.0/kg, straw- Rs. 2.0/kg, Urea- Rs. 6.0/kg, DAP- Rs. 14.0/kg, MOP- Rs. 8.0/kg, FYM- Rs. 1.0/kg, Vermicompost- Rs. 5.0/kg and labor wages- Rs. 300/man-days; *PE = pre-emergence application; PoE = post-emergence application; *fb* = followed by, FYM = farm yard manure; RDN = recommended dose of nitrogen, VC= vermicompost, IN=inorganic nitrogen; DAS = days after seeding

Table 4. Interaction effect of weed management and integrated nutrient management practices on grain yield of finger millet (mean data of 2-years)

Treatment	Weedy check	Hand weeding (HW) twice at 25 and 45 DAS	Pyrazosulfuron 20 g/ha PE <i>fb</i> HW once at 30 DAS	Pyrazosulfuron 20 g/ha PE <i>fb</i> 2,4-D 0.50 kg/ha PoE at 25 DAS	Mean
100% RDN	1715	2581	2501	2190	2247
75% RDN (IN)+25% RDN (FYM)	1521	2431	2302	2026	2070
50% RDN (IN)+50% RDN (FYM)	1033	1955	1566	1433	1497
50% RDN (IN)+25% RDN (FYM)+25% RDN (VC)	1266	2196	1857	1583	1726
Mean	1384	2291	2057	1808	1885
LSD (p=0.05)				166.92	

PE = pre-emergence application; PoE = post-emergence application; *fb* = followed by, FYM = farm yard manure; RDN = recommended dose of nitrogen, VC= vermicompost, IN=inorganic nitrogen; DAS = days after seeding

(1.69), crop productivity, crop profitability. Pyrazosulfuron-ethyl 20 g/ha PE *fb* HW once at 30 DAS was next best treatment, recording higher grain yield and net returns/ha with B:C ratio of 1.65. Pyrazosulfuron-ethyl PE *fb* 2,4-D PoE, though superior to weedy check, resulted in comparatively lower yield, WCE and economics than HW twice 25 and 45 DAS and pyrazosulfuron-ethyl 20 g/ha PE *fb* HW once at 30 DAS.

Nutrient management exerted marked effect on crop yields and economics of finger millet (**Table 3**). Application of 100% recommended dose of N produced the highest grain yield, straw yield, gross returns and net returns with highest B:C ratio (1.99), crop productivity (16.8 kg/ha/day) and crop profitability (Rs. 309.3/ha/day), indicating its economic superiority.

Interaction effect on grain yield

Interaction effect of weed and nutrient management combinations, HW twice at 25 and 45 DAS with 100% RDN recorded the highest grain yield, clearly demonstrating synergistic effect of effective weed control and adequate nutrient supply

(**Table 4**). This treatment was closely followed by pyrazosulfuron-ethyl 20g/ha PE *fb* HW once at 30 DAS with 100% RDN. Considering mean values, HW twice at 25 and 45 DAS recorded the highest mean grain yield among weed management practices, while 100% RDN produced the highest mean grain yield (2247 kg/ha) among the nutrient management treatments.

Pyrazosulfuron-ethyl PE at 20 g/ha followed by hand weeding once at 30 DAS effectively controlled weeds during critical crop growth period. However, hand weeding twice at 25 and 45 DAS proved more economical and resulting in higher returns, better B:C ratio, and improved efficiency. Additionally, applying 100% recommended dose of nitrogen (RDN) significantly enhanced grain and straw yield as well as overall economic benefits.

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