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Impact of nutrient levels and weed management on yield attributes and productivity of finger millet (*Eleusine coracana* L.) Cultivars in the Bastar plateau of Chhattisgarh

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Abstract
A field experiment was conducted during 2022-23 and 2023-24 to assess the effect of varieties, nutrient levels, and weed management practices on yield attributes and yield of finger millet (*Eleusine coracana*) under rainfed conditions of the Bastar plateau. The results revealed significant variation among treatments. Among varieties, CG Ragi-2 (V_2) recorded the highest number of fingers hill^{-1} (9.78), seeds finger^{-1} (230.1), ear head length (10.24 cm), seed yield (23.84 q ha^{-1}), straw yield (42.37 q ha^{-1}), and harvest index (36.01%), outperforming Indira Ragi-1 (V_1) and CG Ragi-3 (V_3). Nutrient levels significantly influenced crop performance, with 125% RDN (N_3) yielding the highest values for number of fingers hill^{-1} (9.64), seeds finger^{-1} (226.8), seed yield (23.47 q ha^{-1}), and straw yield (41.82 q ha^{-1}), indicating the importance of adequate nitrogen for enhancing physiological and reproductive processes. Among weed management practices, hand weeding twice (W_3) resulted in superior yield attributes and yield, with seed yield (23.51 q ha^{-1}), straw yield (42.01 q ha^{-1}), and harvest index (35.88%) on mean basis. The interaction of CG Ragi-2 × 125% RDN × hand weeding twice recorded the highest seed yield (25.36 q ha^{-1}), highlighting the synergistic effect of genotype, fertility, and weed control. This integrated approach proved most effective for maximizing finger millet productivity under rainfed conditions.

Keywords: Nutrient levels, weed management, cultivars, seed yield, straw yield and harvest index

Introduction
Finger millet (*Eleusine coracana* L.), commonly known as ragi, is a vital staple and nutritional cereal crop cultivated primarily in arid and semi-arid regions of India. It holds a significant position in ensuring food and nutritional security, particularly for tribal and marginal farming communities, due to its adaptability to adverse climatic conditions, low input requirements, and exceptional nutritional composition rich in calcium, dietary fibre, and essential amino acids.

Despite its importance, finger millet productivity in many regions, including Chhattisgarh, remains suboptimal. This is primarily due to imbalanced nutrient management and unchecked weed infestation, which lead to nutrient competition, reduced photosynthetic efficiency, and poor crop stand (Rana *et al*., 2020) [13]. The Bastar plateau region of Chhattisgarh, characterized by its rainfed conditions, acidic soils, and traditional cultivation practices, presents unique challenges and opportunities for enhancing finger millet productivity through improved agronomic interventions.

Nutrient management, particularly nitrogen, phosphorus, and potassium (NPK), plays a critical role in influencing the physiological and reproductive growth of finger millet. Adequate nutrient supply enhances panicle formation, grain filling, and ultimately yield. However, excess or unbalanced fertilization can also lead to poor nutrient use efficiency and environmental degradation. Therefore, site-specific nutrient management is essential to achieve both productivity and sustainability goals Weed competition is another major constraint in finger millet production, especially during the early growth stages when the crop is less competitive. Weed infestation not only reduces

yield but also deteriorates grain quality. Integrated weed management practices, combining cultural and chemical methods, have been shown to be effective in minimizing yield losses and improving nutrient uptake and resource use efficiency (Patel *et al*., 2018) [12]. In this context, the present investigation was undertaken to assess the influence of varying nutrient levels and weed management practices on the yield attributes and yield of different finger millet cultivars under the agro-ecological conditions of the Bastar plateau. The study aims to identify optimum combinations of cultivar, nutrient regime, and weed control strategy for enhancing finger millet productivity in the region.

Materials and Methods

The present field investigation titled "Impact of nutrient levels and weed management on yield attributes and productivity of finger millet (*Eleusine coracana* L.) cultivars in the Bastar Plateau of Chhattisgarh" was conducted during the summer seasons of 2021 and 2022 at the Instructional-cum-Research Farm, S.G. College of Agriculture and Research Station, Jagdalpur, under Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh. The experimental site is located between 19°5′ to 20°15′ N latitude and 80°30′ to 82°15′ E longitude, with an elevation of 552 meters above mean sea level. The region experiences a sub- humid climate with monsoonal rainfall, receiving an annual precipitation of 1200-1400 mm, mostly concentrated between June and September.

The experiment was laid out in a split-split plot design with three replications. Treatments consisted of three cultivars: Indira Ragi-1 (V_1), CG Ragi-2 (V_2), and CG Ragi-3 (V_3) as main plots; three nutrient levels 75% RDN (N_1), 100% RDN (N_2), and 125% RDN (N_3) as sub-plots; and four weed management practices as sub-sub plots: W1 (pre-emergence application of Oxadiargyl @ 80 g a.i. ha^{-1} + one mechanical weeding at 40 DAS), W2 (post- emergence application of Bispyribac-sodium @ 20 g a.i. ha^{-1}), W3 (hand weeding twice at 20 and 40 DAS), and W_4 (weedy check). The recommended dose of nutrients was 60:30:30 kg N: P_2O_5:K_2O ha^{-1}, applied through urea, single super phosphate, and muriate of potash, respectively. Nitrogen was applied in two equal splits—half as basal and half at 30 DAS. The crop was sown manually in rows at 30 cm × 10 cm spacing, using a seed rate of 5 kg ha^{-1}. The field was prepared using a tractor-drawn cultivator and levelled with plankers. Gap filling was performed at 10 DAS. Due to adequate rainfall, irrigation was not necessary during the cropping period. Uniform agronomic practices were maintained across all treatments.

Results and Discussion

Number of fingers hill-1

The data on the number of fingers hill-1 in finger millet, as influenced by varieties, nutrient levels, and weed management practices, are presented in Table 1, showing significant differences across treatments during both years and on a mean basis. Among the varieties, Indira Ragi-1 (V_1) recorded the highest number of fingers $hill^{-1}$ in the first year, while CG Ragi- 2 (V_2) produced significantly more fingers $hill^{-1}$ in the second year and on average, likely due to genotypic variation in panicle development and plant vigour (Singh *et al*., 2018; Sharma & Patel, 2020). Nutrient application also had a marked effect, with 125% RDN (N_3) consistently resulting in the highest number of fingers $hill^{-1}$ across both years, reflecting the importance of adequate nutrient availability in supporting photosynthate accumulation, tiller retention, and reproductive development (Kumar *et al*., 2017) [7]. Weed management played a crucial role as well, with hand weeding twice (W3) yielding the highest number of fingers $hill^{-1}$ in both years and on a mean basis, likely due to reduced competition for essential resources, which favoured panicle initiation and growth (Verma *et al*., 2016) [27].

Number of seeds finger -1

The number of seeds finger-1 in finger millet, as influenced by nutrient levels and weed management practices, is presented in Table 1, with statistically significant differences observed across treatments during both years and on a mean basis. Among the varieties, CG Ragi-2 (V_2) consistently produced the highest number of seeds $finger^{-1}$ compared to Indira Ragi-1 (V_1) and CG Ragi-3 (V_3) in both years and on average, indicating superior reproductive efficiency and panicle fertility attributed to genotypic potential (Sharma *et al*., 2020; Meena *et al*., 2021) [20, 9]. Nutrient application had a significant effect, with 125% RDN (N_3) recording the maximum number of seeds $finger^{-1}$, followed by 100% RDN (N_2), while the lowest was observed under 75% RDN (N_1), highlighting the role of higher nutrient availability in enhancing photosynthate production and its allocation to reproductive structures, thereby improving seed filling (Kumar *et al*., 2018; Singh and Verma, 2020) [21, 5]. Weed management practices also significantly affected seed number finger-1, with hand weeding twice (W3) resulting in the highest values, followed by pre-emergence herbicide with mechanical weeding (W1), and post-emergence herbicide (W2), while the weedy check (W_4) recorded the lowest. These results underscore the importance of effective weed control in minimizing competition for nutrients and moisture during key reproductive phases, corroborating findings by Patel *et al*. (2017) [11] and Yadav *et al*. (2022) [28].

Test weight of seed (g)

The data on the test weight of finger millet seeds as influenced by nutrient levels, weed management practices, and varieties are presented in Table 2. Although the differences were statistically non-significant, clear varietal trends were observed. CG Ragi-2 (V_2) consistently recorded the highest test weight across both years and on a pooled mean basis, followed by Indira Ragi-1 (V_1), while the lowest values were noted in CG Ragi-3 (V_3). This trend suggests that genotypic variation influences assimilate partitioning and grain filling efficiency, which ultimately determines seed weight (Rana *et al*., 2020; Kumari *et al*., 2021) [8, 13]. Similarly, nutrient levels did not show statistically significant differences; however, a consistent trend of increased test weight with higher nutrient application was evident, with 125% RDN (N_3) showing the highest values, followed by 100% RDN (N_2), and the lowest under 75% RDN (N_1). These results imply that higher nutrient availability may enhance photosynthetic efficiency and assimilate translocation to developing grains (Singh and Yadav, 2019; Patel *et al*., 2017) [6, 11]. Weed management

practices also exhibited non-significant effects on test weight, but the trend indicated that hand weeding twice (W_3) resulted in the highest test weight, followed by pre-emergence herbicide with mechanical weeding (W_1), and post-emergence herbicide (W_2), while the weedy check (W_4) recorded the lowest. This pattern supports the premise that effective weed control improves resource availability, thereby enhancing grain filling and seed development (Yadav *et al*., 2022) [28].

Ear head length of finger (cm)

The data on ear head length of fingers in finger millet as influenced by different varieties, nutrient levels, and weed management practices are presented in Table 1, with statistical analysis revealing significant differences among treatments during both years and on a mean basis. Among the varieties, CG Ragi-2 (V_2) consistently recorded significantly higher ear head length compared to Indira Ragi-1 (V_1) and CG Ragi-3 (V_3) in both years and on average, likely due to its superior genetic potential for spike elongation and sink strength, which influence reproductive traits (Sharma *et al*., 2018; Rao *et al*., 2021) [15, 19]. Nutrient levels had a marked effect, with 125% RDN (N_3) resulting in the longest ear heads, followed by 100% RDN (N_2), while the shortest ear heads were observed under 75% RDN (N_1). This can be attributed to increased nutrient availability enhancing meristematic activity, cell elongation, and spike growth via improved photosynthetic efficiency and assimilate translocation (Kumar *et al*., 2019; Verma *et al*., 2020) [5, 6]. Weed management also significantly influenced ear head length, with hand weeding twice (W_3) producing the longest ear heads in both years and on mean basis. However, it was statistically at par with pre-emergence application of Oxadiargyl (80 g a.i. ha^{-1}) + one mechanical weeding at 40 DAT (W_1) on the pooled mean. Effective weed control likely reduced competition for essential resources, facilitating better reproductive growth and panicle development (Mishra and Das, 2017; Bhandari *et al*., 2022) [1, 10].

Seed yield (kg ha-1)

Seed yield of finger millet was significantly influenced by variety, nutrient levels, and weed management practices across both years and on a mean basis, as shown in Table 2, highlighting the combined effect of genetic, nutritional, and agronomic factors on crop productivity. Among the cultivars, CG Ragi-2 (V_2) recorded the highest seed yield, followed by Indira Ragi-1 (V_1), while CG Ragi-3 (V_3) consistently produced the lowest yield. These differences can be attributed to genotypic variation in tillering ability, spikelet fertility, grain filling efficiency, and biomass partitioning (Sharma *et al*., 2018; Rao *et al*., 2021; Meena *et al*., 2021) [19, 15, 9]. Superior-performing varieties are also known for their higher physiological efficiency and adaptability to environmental conditions (Rana *et al*., 2020) [13]. Seed yield increased progressively with higher nutrient application, with 125% RDN (N_3) producing significantly greater yields than 100% RDN (N_2) and 75% RDN (N_1), suggesting that enhanced nutrient supply improves chlorophyll content, photosynthetic activity, and assimilate translocation toward grain development (Kumar *et al*., 2019; Singh and Yadav, 2019; Verma *et al*., 2020) [5, 22, 5]. Weed management also had a significant impact, with hand weeding twice (W_3) resulting in the highest seed yield, followed by pre-emergence herbicide combined with mechanical weeding (W_1), and post-emergence herbicide (W_2), while the lowest yield was observed in the weedy check (W_4). Effective weed control likely minimized competition for water, nutrients, and light, thereby supporting enhanced reproductive growth and grain filling (Mishra and Das, 2017; Bhandari *et al*., 2022; Yadav *et al*., 2022) [1, 10].

The interaction effects of variety × nutrient levels, variety × weed management, nutrient levels × weed management, and the three-way interaction of variety × nutrient levels × weed management on seed yield (kg ha^{-1}) of finger millet were found to be statistically significant across both years and on a mean basis (Table 3-6). Among the variety × nutrient level interactions, the combination of CG Ragi-2 (V_2) with 125% RDN (N_3) recorded the highest seed yield, significantly surpassing all other combinations. This superior performance is attributed to the higher genetic yield potential of CG Ragi-2 and its responsiveness to increased nitrogen input, corroborating the findings of Sharma *et al*. (2016) and Kumari *et al*. (2017). In the variety × weed management interaction, CG Ragi-2 (V_2) under hand weeding twice (W_3) produced the highest seed yield across all observations, likely due to efficient weed suppression that reduced resource competition and enhanced plant growth and productivity (Chauhan and Johnson, 2010; Tiwari *et al*., 2018) [2, 25]. Similarly, in the nutrient level × weed management interaction, 125% RDN (N_3) combined with hand weeding twice (W_3) yielded significantly more than other treatment combinations, reflecting the synergistic benefits of higher nutrient availability and effective weed control (Rao *et al*., 2009; Gharde *et al*., 2018) [14, 3]. The three-way interaction among CG Ragi-2 (V_2), 125% RDN (N_3), and hand weeding twice (W_3) consistently resulted in the highest seed yield across both years and on average, underscoring the importance of integrating high-yielding cultivars, optimal nutrient management, and efficient weed control for maximizing finger millet productivity under rainfed conditions (Somasundaram *et al*., 2009) [24].

Straw yield (kg ha-1)

Straw yield of finger millet was significantly influenced by variety, nutrient levels, and weed management across both years and on a mean basis (Table 2), emphasizing the importance of integrated agronomic practices in enhancing total biomass productivity. Among the varieties, CG Ragi-2 (V_2) consistently recorded the highest straw yield, followed by Indira Ragi-1 (V_1), while the lowest was observed in CG Ragi-3 (V_3). The superior performance of V_2 is likely due to its vigorous vegetative growth, higher leaf area index, and robust plant architecture, all of which contribute to greater dry matter accumulation (Sharma *et al*., 2018; Rao *et al*., 2021) [15, 19]. Genotypic variation in physiological efficiency and biomass partitioning is a known factor influencing straw yield in small millets (Meena *et al*., 2021) [9]. Nutrient levels also had a significant effect, with 125% RDN (N_3) resulting in the highest straw yield, followed by 100% RDN (N_2) and the lowest under 75% RDN (N_1). This trend can be attributed to improved chlorophyll content, photosynthesis, and vegetative growth under higher nutrient availability,

particularly nitrogen, which plays a key role in cell division and elongation essential for shoot and leaf development (Kumar *et al*., 2019; Verma *et al*., 2020; Singh and Yadav, 2019) [5, 6, 22]. Weed management significantly impacted straw yield, with hand weeding twice (W_3) yielding the highest, followed by pre-emergence herbicide + mechanical weeding (W_1) and post-emergence herbicide (W_2), while the weedy check (W_4) recorded the lowest. Effective weed control during early crop growth likely reduced competition for vital resources, allowing for better canopy development and overall biomass production (Mishra and Das, 2017; Bhandari *et al*., 2022) [1, 10].

The interaction effects of variety × nutrient levels, variety × weed management, nutrient levels × weed management, and the three-way interaction of variety × nutrient levels × weed management on straw yield (kg ha^{-1}) of finger millet were statistically significant during both years and on a mean basis (Table 7-10). Among the variety × nutrient level combinations, CG Ragi-2 (V_2) with 125% RDN (N_3) consistently produced the highest straw yield, significantly outperforming other treatments. This enhanced biomass accumulation is attributed to the vigorous vegetative growth and higher structural biomass potential of CG Ragi-2, further amplified by increased nitrogen availability that promotes cell division and elongation (Sharma *et al*., 2016; Kumari *et al*., 2017) [20, 7]. In the variety × weed management interaction, CG Ragi-2 (V_2) with hand weeding twice (W_3) recorded significantly higher straw yield due to improved weed suppression, which minimized competition for light, nutrients, and water facilitating robust plant growth (Chauhan and Johnson, 2010; Tiwari *et al*., 2018) [2, 25]. Likewise, in the nutrient level × weed management interaction, 125% RDN (N_3) combined with hand weeding twice (W_3) yielded the highest biomass, reflecting the synergistic effect of optimal nutrition and effective weed control in enhancing vegetative vigour (Rao *et al*., 2009; Gharde *et al*., 2018) [14, 3]. The three-way interaction of CG Ragi-2 (V_2), 125% RDN (N_3), and hand weeding twice (W_3) recorded the highest straw yield across both years and on a mean basis, indicating that integrating a high-performing genotype with adequate nutrient supply and efficient weed management is essential for maximizing straw yield in finger millet under rainfed conditions (Somasundaram *et al*., 2009) [24].

Harvest index (%)

The harvest index (HI) of finger millet was significantly influenced by variety, nutrient levels, and weed management across both years and on a mean basis (Table 2), underscoring the importance of integrated agronomic practices in optimizing biomass partitioning towards grain production. Among the varieties, CG Ragi-2 (V_2) consistently recorded the highest HI, followed by Indira Ragi-1 (V_1), while CG Ragi-3 (V_3) recorded the lowest across both years and on mean basis, likely due to genotypic traits such as superior assimilate translocation and grain filling efficiency (Sharma *et al*., 2018; Rao *et al*., 2021) [15, 19]. Nutrient levels also had a

Table 1: Effect of varieties, nutrient level and weed management practices on number of fingers, number of seed finger-1, test weight and ear head lent of finger in finger millet

Treatment		Seed yield (kg ha-1)			Straw yield (kg ha-1)			Harvest index (%)	
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Varieties									
V1: Indira Ragi-1	1540	1613	1576	2654	2680	2667	36.24	37.14	36.69
V2: CG Ragi-2	1775	1846	1811	2795	2821	2808	38.26	39.01	38.64
V3: CG Ragi-3	1479	1552	1515	2560	2587	2574	36.10	37.03	36.56
SEm±	0.62	0.87	0.70	5.83	5.83	5.83	0.08	0.07	0.07
CD (P=0.05)	2.43	3.41	2.75	22.89	22.89	22.89	0.33	0.26	0.29
Nutrient levels									
N1:75% RDN	1494	1567	1530	2564	2591	2578	36.31	37.23	36.77
N2:100% RDN	1612	1686	1649	2653	2679	2666	37.20	38.06	37.63
N3:125% RDN	1688	1758	1723	2791	2818	2805	37.10	37.89	37.50
SEm±	0.91	1.20	0.64	7.10	7.10	7.10	0.11	0.11	0.11
CD (P=0.05)	2.80	3.70	1.97	21.87	21.87	21.87	0.33	0.32	0.32
Weed management practices									
W1	1770	1839	1804	2766	2792	2779	38.95	39.65	39.30
W2	1735	1808	1772	2734	2761	2748	38.76	39.52	39.14
W3	1884	1957	1920	2858	2885	2872	39.63	40.33	39.98
W4	1003	1077	1040	2319	2346	2333	30.14	31.41	30.77
SEm±	1.95	2.18	1.54	5.83	5.83	5.83	0.13	0.13	0.13
CD (P=0.05)	5.54	6.17	4.38	16.54	16.54	16.54	0.38	0.37	0.37

Note: W1: Oxadiargyl 80 g a.i. ha-1, PE + One mechanical weeding at 40 DAT, W2: Bispyribac Na 20 g a.i .ha-1, PoE, W3: Hand weeding twice at 20 and 40 DAT and W4: Weedy check

Table 2: Effect of varieties, nutrient level and weed management practices on seed yield, straw yield and harvest index in finger millet

Treatment	Seed yield (kg ha-1)			Straw yield (kg ha-1)			Harvest index (%)		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Varieties									
V1: Indira Ragi-1	1540	1613	1576	2654	2680	2667	36.24	37.14	36.69
V2: CG Ragi-2	1775	1846	1811	2795	2821	2808	38.26	39.01	38.64
V3: CG Ragi-3	1479	1552	1515	2560	2587	2574	36.10	37.03	36.56
SEm±	0.62	0.87	0.70	5.83	5.83	5.83	0.08	0.07	0.07
CD (P=0.05)	2.43	3.41	2.75	22.89	22.89	22.89	0.33	0.26	0.29
Nutrient levels									
N1:75% RDN	1494	1567	1530	2564	2591	2578	36.31	37.23	36.77
N2:100% RDN	1612	1686	1649	2653	2679	2666	37.20	38.06	37.63
N3:125% RDN	1688	1758	1723	2791	2818	2805	37.10	37.89	37.50
SEm±	0.91	1.20	0.64	7.10	7.10	7.10	0.11	0.11	0.11
CD (P=0.05)	2.80	3.70	1.97	21.87	21.87	21.87	0.33	0.32	0.32
Weed management practices									
W1	1770	1839	1804	2766	2792	2779	38.95	39.65	39.30
W2	1735	1808	1772	2734	2761	2748	38.76	39.52	39.14
W3	1884	1957	1920	2858	2885	2872	39.63	40.33	39.98
W4	1003	1077	1040	2319	2346	2333	30.14	31.41	30.77
SEm±	1.95	2.18	1.54	5.83	5.83	5.83	0.13	0.13	0.13
CD (P=0.05)	5.54	6.17	4.38	16.54	16.54	16.54	0.38	0.37	0.37

Note: W1: Oxadiargyl 80 g a.i. ha-1, PE + One mechanical weeding at 40 DAT, W2: Bispyribac Na 20 g a.i .ha-1, PoE, W3: Hand weeding twice at 20 and 40 DAT and W4: Weedy check

Table 3: Interaction effect of varieties and nutrient levels on seed yield of finger millet

Treatment	N1:75% RD	Seed yield (kg ha-1)		
Nutrient levels		**N2:100% RDN**	**N3:125% RDN**	**Mean**
Varieties	**2021**			
V1: Indira Ragi-1	1503	1540	1577	1540
V2: CG Ragi-2	1575	1812	1939	1775
V3: CG Ragi-3	1403	1486	1548	1479
Mean	1493.61	1612.44	1687.72	
2022				
V1: Indira Ragi-1	1576	1613	1650	1613
V2: CG Ragi-2	1648	1885	2004	1846
V3: CG Ragi-3	1477	1559	1621	1552
Mean	1566.94	1685.78	1758.28	
Two years mean				
V1: Indira Ragi-1	1539	1577	1613	1576
V2: CG Ragi-2	1612	1848	1972	1811
V3: CG Ragi-3	1440	1522	1584	1515
Mean	1530.28	1649.11	1723.00	

	2021		2022		Two years mean	
	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
V at same N	1.57	4.85	2.08	6.41	1.11	3.42
N at same V	2.03	6.59	3.63	11.84	1.31	4.45

Table 4: Interaction effect of varieties and weed management practices on seed yield of finger millet

Treatment	W1	W2	Seed yield (kg ha-1)		
Weed mgt. Practices			**W3**	**W4**	**Mean**
Varieties	**2021**				
V1: Indira Ragi-1	1698	1679	1806	977	1540
V2: CG Ragi-2	1968	1912	2111	1110	1775
V3: CG Ragi-3	1643	1614	1734	923	1479
Mean	1769.63	1735.15	1883.70	1003.22	
2022					
V1: Indira Ragi-1	1771	1752	1879	1050	1613
V2: CG Ragi-2	2030	1985	2184	1183	1846
V3: CG Ragi-3	1717	1688	1808	996	1552
Mean	1839.26	1808.48	1957.04	1076.56	
Two years mean					
V1: Indira Ragi-1	1734	1716	1842	1013	1576
V2: CG Ragi-2	1999	1949	2148	1147	1811
V3: CG Ragi-3	1680	1651	1771	960	1515
Mean	1804.44	1771.81	1920.37	1039.89	

	2021		2022		Two years mean	
	SEm±	**CD (P=0.05)**	**SEm±**	**CD (P=0.05)**	**SEm±**	**CD (P=0.05)**
V at same W	3.18	9.59	3.56	10.69	2.52	7.58
W at same V	8.57	25.85	11.06	33.19	5.70	17.14

Note: W1: Oxadiargyl 80 g a.i. ha-1, PE + One mechanical weeding at 40 DAT, W2: Bispyribac Na 20 g a.i .ha-1, PoE, W3: Hand weeding twice at 20 and 40 DAT and W4: Weedy check

Table 5: Interaction effect of varieties and nutrient levels on seed yield of finger millet

Treatment			Seed yield (kg ha-1)			
Nutrient levels	**N1:75% RD**		**N2:100% RDN**		**N3:125% RDN**	**Mean**
Weed mgt. pract.	**2021**					
W1	1652		1786		1871	1770
W2	1633		1750		1822	1735
W3	1743		1917		1991	1884
W4	945		998		1067	1003
Mean	1493.61		1612.44		1687.72	
2022						
W1	1726		1859		1933	1839
W2	1707		1823		1895	1808
W3	1817		1990		2064	1957
W4	1019		1071		1140	1077
Mean	1566.94		1685.78		1758.28	
Two years mean						
W1	1689		1822		1902	1804
W2	1670		1787		1859	1772
W3	1780		1953		2028	1920
W4	982		1034		1103	1040
Mean	1530.28		1649.11		1723.00	
	2021		2022		Two years mean	
	SEm±	**CD (P=0.05)**	**SEm±**	**CD (P=0.05)**	**SEm±**	**CD (P=0.05)**
W at same N	3.19	9.59	3.56	10.69	2.51	7.58
N at same W	8.91	26.89	11.50	34.67	5.47	16.47

Note: W1: Oxadiargyl 80 g a.i. ha-1, PE + One mechanical weeding at 40 DAT, **W2:** Bispyribac Na 20 g a.i .ha-1, PoE, **W3:** Hand weeding twice at 20 and 40 DAT and **W4:** Weedy check

Table 6: Interaction effect of varieties, nutrient levels and weed management practiceson seed yield of finger millet

Treatment	Seed yield (kg ha-1)														
W	W1	W2	W3	W4	Mean	W1	W2	W3	W4	Mean	W1	W2	W3	W4	Mean
V X N	**2021**					**2022**					**Two years mean**				
V1N1	1657	1647	1760	947	1503	1730	1720	1833	1020	1576	1693	1684	1797	983	1539
V1N2	1700	1680	1810	970	1540	1773	1753	1883	1043	1613	1737	1717	1847	1007	1577
V1N3	1737	1710	1847	1013	1577	1810	1783	1920	1087	1650	1773	1747	1883	1050	1613
V2N1	1730	1707	1837	1027	1575	1803	1780	1910	1100	1648	1767	1743	1873	1063	1612
V2N2	2013	1953	2183	1097	1812	2087	2027	2257	1170	1885	2050	1990	2220	1133	1848
V2N3	2160	2076	2313	1207	1939	2200	2149	2387	1280	2004	2180	2113	2350	1243	1972
V3N1	1570	1547	1633	863	1403	1643	1620	1707	936	1477	1607	1583	1670	900	1440
V3N2	1643	1617	1757	926	1486	1717	1690	1830	999	1559	1680	1653	1793	963	1522
V3N3	1717	1680	1813	980	1548	1790	1753	1887	1053	1621	1753	1717	1850	1017	1584
Mean	1770	1735	1884	1003		1839	1808	1957	1077		1804	1772	1920	1040	
	SEm±		CD (P=0.05)			SEm±		CD (P=0.05)			SEm±		CD (P=0.05)		
V at same N & W	5.27		16.85			5.97		19.27			4.47		13.80		
V X N X W	5.54		16.62			6.27		18.82			4.37		13.13		

Table 7: Interaction effect of varieties and nutrient levels on stover yield of finger millet

Treatment / Year	N1: 75% RDN	N2: 100% RDN	N3: 125% RDN	Mean
2021				
V1: Indira Ragi-1	2590	2635	2736	2654
V2: CG Ragi-2	2646	2762	2976	2795
V3: CG Ragi-3	2458	2561	2663	2560
Mean	2564.33	2652.64	2791.44	
2022				
V1: Indira Ragi-1	2616	2662	2762	2680
V2: CG Ragi-2	2672	2789	3003	2821
V3: CG Ragi-3	2484	2587	2690	2587
Mean	2591.00	2679.31	2818.11	
Two years mean				
V1: Indira Ragi-1	2603	2649	2749	2667
V2: CG Ragi-2	2659	2775	2989	2808
V3: CG Ragi-3	2471	2574	2676	2574
Mean	2577.67	2665.97	2804.78	
Statistical Analysis				
Year	**SEm± (V at same N)**	**CD (P=0.05)**	**SEm± (N at same V)**	**CD (P=0.05)**
2021	12.19	37.58	132.76	437.95
2022	12.29	37.88	134.76	443.95
Two years mean	12.20	36.60	130.25	390.75

Table 8: Interaction effect of varieties and weed management practices on stover yield of finger millet

Treatment			**Stover yield (kg ha-1)**		
Weed mgt practices	**W1**	**W2**	**W3**	**W4**	**Mean**
Varieties			**2021**		
V1: Indira Ragi-1	2737	2730	2846	2301	2654
V2: CG Ragi-2	2914	2850	2990	2423	2795
V3: CG Ragi-3	2646	2623	2739	2234	2560
Mean	2765.63	2734.44	2858.41	2319.41	
V1: Indira Ragi-1	2764	2757	2873	2328	2680
V2: CG Ragi-2	2941	2877	3017	2450	2821
V3: CG Ragi-3	2672	2650	2765	2261	2587
Mean	2792.30		2761.11	2885.07	2346.07
Two years mean					
V1: Indira Ragi-1	2750	2744	2859	2314	2667
V2: CG Ragi-2	2928	2863	3004	2437	2808
V3: CG Ragi-3	2659	2636	2752	2247	2574
Mean	2778.96	2747.78	2871.74	2332.74	
	2021		**2022**		**Two years mean**
	SEm±	**CD (P=0.05)**	**SEm±**	**CD (P=0.05)**	**SEm±**	**CD (P=0.05)**
V at same W	9.20	27.64	9.50	28.50	8.21	24.63
W at same V	110.53	345.48	115.20	345.60	111.1	333.3

Note;-W1: Oxadiargyl 80 g a.i. ha-1, PE + One mechanical weeding at 40 DAT, **W2:** Bispyribac Na 20 g a.i .ha-1 , PoE, **W3:** Hand weeding twice at 20 and 40 DAT and **W4:** Weedy check

Table 9: Interaction effect of varieties and nutrient levels on stover yield of finger millet

Treatment	**Stover yield (kg ha-1)**					
Nutrient levels	**N1:75% RDN**		**N2:100% RDN**		**N3:125% RDN**	**Mean**
Weed mgt. pract.	**2021**					
W1	2656	2739	2902		2766	
W2	2636	2717	2850		2734	
W3	2734	2846	2995		2858	
W4	2231	2308	2419		2319	
Mean	2564.33	2652.64	**2791.44**			
2022						
W1	2682	2766	2928		2792	
W2	2663	2744	2877		2761	
W3	2761	2872	3022		2885	
W4	2258	2335	2446		2346	
Mean	2591.00	2679.31	2818.11			
Two years mean						
W1	2669	2753	2915		2779	
W2	2649	2731	2863		2748	
W3	2748	2859	3008		2872	
W4	2245	2321	2432		2333	
Mean	2577.67	2665.97	2804.78			
	2021	2022	**Two years mean**			
	SEm±	**CD (P=0.05)**	**SEm±**	**CD (P=0.05)**	**SEm±**	**CD (P=0.05)**
W at same N	9.20	27.64	9.50	28.50	8.21	24.63
N at same W	124.09	372.29	124.36	373.09	123.38	370.16

Note;-W1: Oxadiargyl 80 g a.i. ha-1, PE + One mechanical weeding at 40 DAT, W2: Bispyribac Na 20 g a.i .ha-1, PoE, W3: Hand weeding twice at 20 and 40 DAT and W4: Weedy check

Table 10: Interaction effect of varieties, nutrient levels and weed management practiceson stover yield of finger millet

Treatment	**Stover yield (kg ha-1)**														
W	**W1**	**W2**	**W3**	**W4**	**Mean**	**W1**	**W2**	**W3**	**W4**	**Mean**	**W1**	**W2**	**W3**	**W4**	**Mean**
d	**2021**					**2022**					**Two years mean**				
V1N1	2676	2664	2776	2242	2590	2703	2691	2803	2269	2616	2690	2677	2789	2256	2603
V1N2	2718	2703	2833	2287	2635	2744	2730	2860	2313	2662	2731	2717	2847	2300	2649
V1N3	2817	2823	2929	2374	2736	2843	2850	2956	2400	2762	2830	2837	2942	2387	2749
V2N1	2733	2707	2810	2333	2646	2760	2733	2837	2359	2672	2747	2720	2824	2346	2659
V2N2	2860	2833	2944	2411	2762	2887	2860	2971	2437	2789	2873	2847	2957	2424	2775
V2N3	3150	3010	3217	2527	2976	3177	3037	3243	2553	3003	3163	3023	3230	2540	2989
V3N1	2557	2537	2617	2119	2458	2584	2564	2644	2145	2484	2571	2551	2630	2132	2471
V3N2	2641	2615	2760	2227	2561	2667	2642	2787	2253	2587	2654	2629	2773	2240	2574
V3N3	2739	2717	2839	2357	2663	2765	2743	2866	2383	2690	2752	2730	2853	2370	2676
Mean	2766	2734	2858	2319		2792	2761	2885	2346		2779	2748	2872	2333	
		SEm±		**CD (P=0.05)**		**SEm±**			**CD (P=0.05)**		**SEm±**			**CD (P=0.05)**	
V at same N & W		20.09		62.87		21.02			63.22		20.03			60.27	
V X N X W		16.51		49.61		16.73			50.21		16.05			48.16	

Table 11: Interaction effect of varieties and nutrient levels on harvest index of finger millet

Treatment	Harvest index					
Nutrient levels	N1:75% RDN		N2:100% RDN		N3:125% RDN	Mean
Varieties	2021					
V1: Indira Ragi-1	36.23	36.39	36.11		36.24	
V2: CG Ragi-2	36.88	38.99	38.91		38.26	
V3: CG Ragi-3	35.82	36.21	36.27		36.10	
Mean	36.31	37.20	37.10			
2022						
V1: Indira Ragi-1	37.14	37.29	36.98		37.14	
V2: CG Ragi-2	37.75	39.76	39.54		39.01	
V3: CG Ragi-3	36.80	37.13	37.16		37.03	
Mean	37.23	38.06	37.89			
Two year mean						
V1: Indira Ragi-1	36.68	36.84	36.55		36.69	
V2: CG Ragi-2	37.31	39.37	39.22		38.64	
V3: CG Ragi-3	36.31	36.67	36.72		36.56	
Mean	36.77	37.63	37.50			
	2021	2022	Two years mean			
SEm±		**CD (P=0.05)**	**SEm±**	**CD (P=0.05)**	**SEm±**	**CD (P=0.05)**
V at same N	0.12	0.37	0.11	0.34	0.11	0.35
N at same V	0.01	0.04	0.01	0.04	0.01	0.04

significant effect, with the highest HI observed under 100% RDN (N_2), statistically at par with 125% RDN (N_3), and the lowest under 75% RDN (N_1), indicating that optimal nutrient supply enhances photosynthesis and dry matter allocation to the grain (Kumar *et al*., 2019; Reddy *et al*., 2020) [15, 19]. Weed management practices significantly influenced HI, with hand weeding twice (W_3) resulting in the highest index, followed by pre-emergence herbicide + mechanical weeding (W_1) and post-emergence herbicide (W_2), while the lowest HI was recorded under the weedy check (W_4). Effective weed control likely reduced competition for nutrients and light, thereby promoting reproductive growth (Mishra & Das, 2017) [1].

The interaction between variety and nutrient level (Table 11) was also significant, with the combination of CG Ragi-2 (V_2) and 100% RDN (N_2) recording the highest HI, statistically at par with V_2 × 125% RDN (N_3). The improved HI under these combinations may be attributed to efficient dry matter partitioning towards grain yield, driven by genotypic vigour and balanced nutrient availability (Sharma *et al*., 2016; Kumari *et al*., 2017; Ramesh *et al*., 2002) [20, 7, 16]. These findings highlight the need to select nutrient-responsive genotypes and optimize nitrogen levels to enhance physiological efficiency and grain productivity in finger millet.

Conclusion

The study clearly demonstrated that the productivity and yield attributes of finger millet are significantly influenced by the interaction of varieties, nutrient levels, and weed management practices. Among the varieties, CG Ragi-2 (V_2) consistently outperformed others in terms of number of fingers hill^{-1}, seeds finger^{-1}, ear head length, seed yield, straw yield, and harvest index, highlighting its superior genetic potential and adaptability under rainfed conditions. Nutrient application at 125% recommended dose of nitrogen (RDN) (N_3) was found to be most effective in enhancing all yield attributes and yields, emphasizing the critical role of optimal nutrient availability, particularly nitrogen, in improving physiological processes like photosynthesis, tillering, and assimilate translocation. Among the weed management practices, hand weeding twice (W_3) proved to be the most effective, consistently recording the highest values for all parameters. This indicates the importance of efficient weed control in reducing competition for essential growth resources and enhancing crop performance. Significant interaction effects were observed across variety × nutrient level, variety × weed management, nutrient level × weed management, and the three-way interaction. The combination of CG Ragi-2 (V_2), 125% RDN (N_3), and hand weeding twice (W_3) consistently recorded the highest seed and straw yields, demonstrating the synergistic impact of integrating high-yielding cultivars, adequate nutrient supply, and effective weed control practices. Overall, the findings underscore the importance of adopting an integrated crop management approach, which includes genotype selection, site-specific nutrient application, and timely weed control, for maximizing yield and resource-use efficiency in finger millet under rainfed agro-ecosystems.

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