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Effect of Finger Millet Residue Management on Equivalent Yield, Profitability, Plant Nutrient Uptake and Soil Nutrient Dynamics in Succeeding Legume Crops

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Finger Millet (*Eleusine coracana* L. Gaertn) is an excellent source of calcium, iron, dietary fibre, and methionine, an essential amino acid typically deficient in rice and wheat. In addition to its grain, finger millet produces a nutrient-dense straw that serves as both valuable livestock fodder and a potential source of soil organic carbon. The present study was designed and conducted to assess

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the impact of finger millet residue management with ANGRAU decomposer on the yield, profitability and nutrient uptake of subsequent legume crops under upland conditions. A field experiment was conducted during *rabi*, 2024-25 at the Agricultural Research Station, Vizianagaram, Andhra Pradesh, India, to assess the impact of finger millet residue management practices on subsequent legume crops. The experiment was conducted in a split-plot design with three replications. The main plot treatments include finger millet residue incorporation (M_1), finger millet residue incorporation + ANGRAU decomposer (M_2) and no residue incorporation (M_3); the subplot treatments include the legume crops *viz*., sunhemp, horsegram, groundnut, blackgram and greengram. The data were statistically analysed using ANOVA. Treatment means were compared using the F-test at a 5% significance level, and critical differences were calculated wherever significant. The experimental results revealed that finger millet residue incorporation + ANGRAU decomposer (M_2) resulted in significantly higher finger millet equivalent yield (FMEY)(2075 kg ha^{-1}), net returns (Rs.151,286.00 ha^{-1}), BCR (2.13), plant nutrient uptake and soil available nutrients (N_2-243.2 kg ha^{-1}, P_2O_5- 32.9 kg ha^{-1}, K_2O-330.8 kg ha^{-1}). Among the legume crops, the groundnut crop resulted in higher FMEY (3333 kg ha^{-1}), Net returns (Rs.91844 ha^{-1}), BCR (2.57) and kernel nutrient uptake as compared to other legume crops. Among different treatment combinations, groundnut in combination with finger millet residue incorporation coupled with ANGRAU decomposer, resulted in significantly higher finger millet equivalent yield (3646 kg ha^{-1}), net returns (Rs.1,03,819.00 ha^{-1}), plant nutrient uptake and soil available nutrients; however, it remained on par with groundnut with finger millet residue incorporation. With the adoption of finger millet residue management along with ANGRAU decomposer, the finger millet-groundnut cropping system will become a viable cropping system for upland ecosystems.

Keywords: Finger millet; residue management; legume crops; soil nutrient dynamics.

1. INTRODUCTION

Finger millet (*Eleusine coracana* L. Gaertn) is a climate-resilient and nutrient-rich crop well-suited for low-input farming systems. "Finger millet has the distinction of having the highest productivity among millets, accounting for nearly 85 per cent of the production in India. In India, the area, production, and productivity are 10.37 lakh ha, 13.86 lakh tonnes and 1336 kg ha-1, respectively" (Korade et al., 2025). "It is an excellent source of calcium, iron, dietary fibre, and methionine, an essential amino acid typically deficient in rice and wheat" (Nagaraja et al., 2024). "In addition to its grain, finger millet produces a nutrient-dense straw that serves as both valuable livestock fodder and a potential source of soil organic carbon. In addition, finger millet is a C_4 plant that sequesters carbon more efficiently, thereby allowing CO_2 abatement, which is also beneficial to the environment. Therefore, this crop has become an automatic choice in dry farming systems" (Pramanick et al., 2024). "Despite these benefits, finger millet straw is often burned or discarded, resulting in nutrient depletion and environmental harm" (Ebanyat et al., 2021). "Harnessing this biomass through in-situ incorporation or microbial decomposition offers a promising strategy to enhance soil structure, nutrient cycling, and overall system sustainability" (Gautam et al., 2025). "Decomposers involving bacteria and fungi are essential for breaking down the complex organic substances like cellulose, hemicellulose, lignin, etc, into simpler forms by secreting certain enzymes and releasing nutrients into the soil. Application of decomposers on crop residue under sufficient moisture conditions not only hastens the decomposition process but also supports sustainable farming" (Shafi et al., 2010). Integrating cereal residue management with legume-based cropping systems represents a pathway for ecological intensification. Legumes such as sunhemp, green gram, black gram, horse gram and groundnut contribute to biological nitrogen fixation, enhance soil microbial communities, and reduce reliance on synthetic fertilisers. Against this backdrop, the present study was designed and conducted to assess the impact of finger millet residue management with ANGRAU decomposer on the yield, profitability and nutrient uptake of subsequent legume crops under upland conditions.

2. MATERIALS AND METHODS

A field experiment was carried out during the *rabi* season of 2024-25 at the Agricultural Research Station, Vizianagaram, under Acharya N.G. Ranga Agricultural University, Andhra Pradesh. The experimental site is located in the North

Coastal Agro-climatic Zone of Andhra Pradesh (18°07′ N latitude, 83°25′ E longitude, 63 m AMSL). The experiment was laid out in a split-plot design with three replications. The main plot factor comprised three finger millet residue management practices: M_1: Finger millet residue incorporation; M_2: M_1 + ANGRAU decomposer; M_3: No residue incorporation. The sub-plot factor included five legume crops: S_1: Sunhemp, S_2: Horsegram, S_3: Groundnut, S_4: Blackgram, S_5: Greengram. Each gross plot measured 4.5 m × 4.0 m with a net plot size of 3.3 m × 3.6 m. The experimental field soil was sandy loam in texture, neutral in pH (6.93), non-saline (EC 0.23 dS m^{-1}), and low in organic carbon (0.45%) and available nitrogen (219 kg ha^{-1}). It had medium levels of phosphorus (21.5 kg ha^{-1}) and potassium (305.5 kg ha^{-1}). After harvesting the preceding finger millet crop, the residues were managed based on the main plot treatments. In M_1 and M_2, finger millet residue @ 5 t ha^{-1} was chopped with a shredder and incorporated using a power weeder up to a depth of 30-35 cm. In M_2, ANGRAU decomposer (2.5 kg each of decomposer A and B per hectare in 500 L of water) was sprayed after residue application under sufficient moisture conditions. It was obtained from the Agricultural Research Station, Amaravati. ANGRAU decomposer A, comprising fungi (*Aspergillus, Pleurotus, Trichoderma* and *Phenerochaete*) and ANGRAU decomposer B, comprising bacteria (*Cellulomonas, Bacillus, Pseudomonas* and *Micrococcus*). In M_1 and M_2 treatments, optimum moist condition was maintained, and residue was turned twice at a weekly interval with the help of a power weeder. A period of 30 days was left for the complete decomposition of the residue. After that, the land was prepared thoroughly with a rotovator to a fine tilth. Legume seeds were sown manually at a spacing of 30 × 10 cm. Crop-specific seed rates and recommended fertilisers were applied. Irrigation was given immediately after sowing and during the critical growth stages of the respective crops. Pendimethalin was applied as a pre-emergence herbicide for weed control. Need-based crop management practices were adopted. Observations like grain yield and haulm yield were recorded after harvest. Finger millet equivalent yield (FMEY) and economics were calculated using standard price-based conversion. Soil samples were collected before sowing and after harvest for analysis of pH, EC, organic carbon, and available N, P, and K using standard methods. Grain and straw samples were analysed for nutrient content (N, P, K), and uptake was computed. The data were statistically analysed using ANOVA as per the method described by Panse and Sukhatme (1978). Treatment means were compared using the F-test at a 5% significance level, and critical differences were calculated wherever significant.

3. RESULTS AND DISCUSSION

3.1 Grain Yield and Haulm Yield (kg ha^{-1})

The grain and haulm yield of various legume crops were significantly influenced by finger millet residue management practices (Fig. 1&2). All the legume crops (sunhemp, horse gram, groundnut, black gram and green gram) recorded higher grain and haulm yields with M_2 (Finger millet residue incorporation + ANGRAU decomposer), which was closely followed by M_1 (Finger millet residue incorporation); whereas the lowest grain and haulm yields were recorded in no residue incorporation (M_3). Among the crops, groundnut recorded a higher pod yield (2306 kg ha^{-1}) in M_2 (Finger millet residue incorporation + ANGRAU decomposer), which was 4.7% and 27.0% higher than M_1 and $M_{3,}$ respectively. The grain yield of sunhemp and horsegram obtained in M_2 showed an increase of 9.5% and 10.2%, respectively, as compared to M_1 (Finger millet residue incorporation) and 43.2% and 21.6% as compared to M_3 (no residue incorporation). Similarly, blackgram and greengram showed and yield increase of 17.5% and 18.8%, respectively, under M_2 (Finger millet residue incorporation + ANGRAU decomposer) as compared to M_3 (no residue incorporation).

Among the five legume crops, the haulm yield of groundnut was higher in M_2 (3730 kg ha-1), which was 3.4% and 11.9% higher, respectively, as compared to M_1 and M_3. Similarly, sunhemp, horse gram, black gram and green gram recorded higher haulm yield with M_2 (2631, 1906, 2288 and 2191 kg ha^{-1}, respectively) as compared to M_1 (2566, 1858, 2182 and 2120 kg ha^{-1}, respectively) and M_3(2299, 1716, 2082 and 1970 kg ha^{-1}, respectively). The enhanced grain haulm yield observed under M_2 (finger millet residue incorporation with ANGRAU decomposer) might be attributed to the rapid decomposition of crop residues by the microbial consortium, which in turn contributed to improved soil structure, water holding capacity, microbial diversity and nutrient availability to the subsequent crops. These findings align with Ratnam et al. (2023), who reported that foxtail millet residue combined with a bio-fertiliser consortium significantly improved Bengal gram productivity. Davari et al. (2012) and

Raghavendra et al. (2018) documented better pod formation and yield in mung bean through the combined application of rice and wheat crop residues.

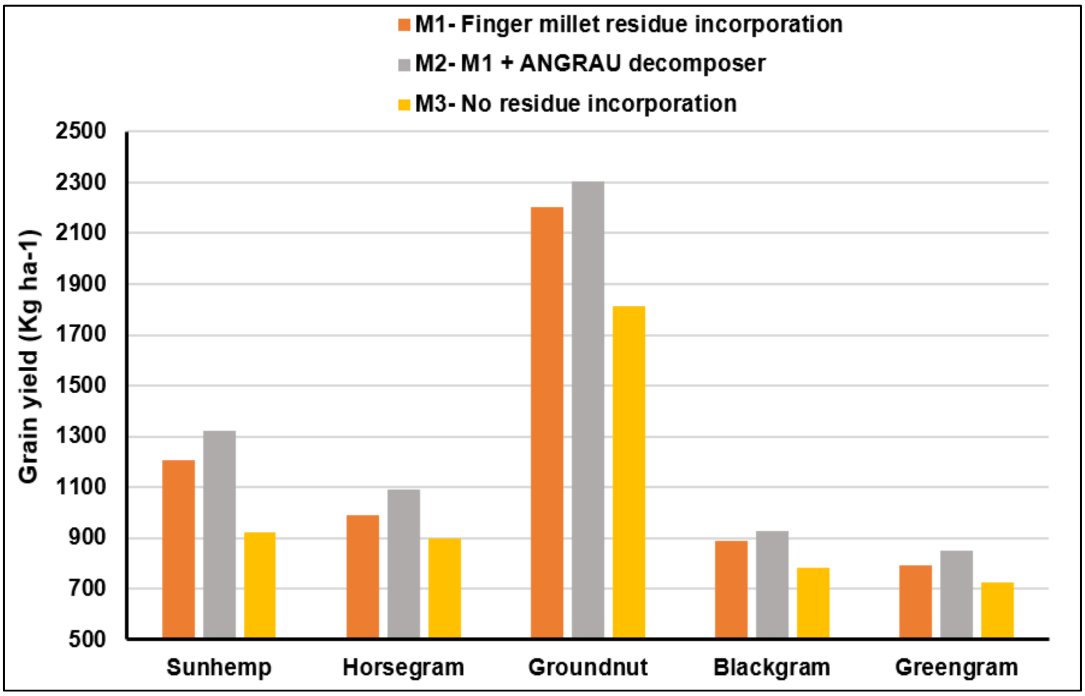

Fig. 1. Grain yield (kg ha^{-1}) of various legume crops as influenced by finger millet residue management practices

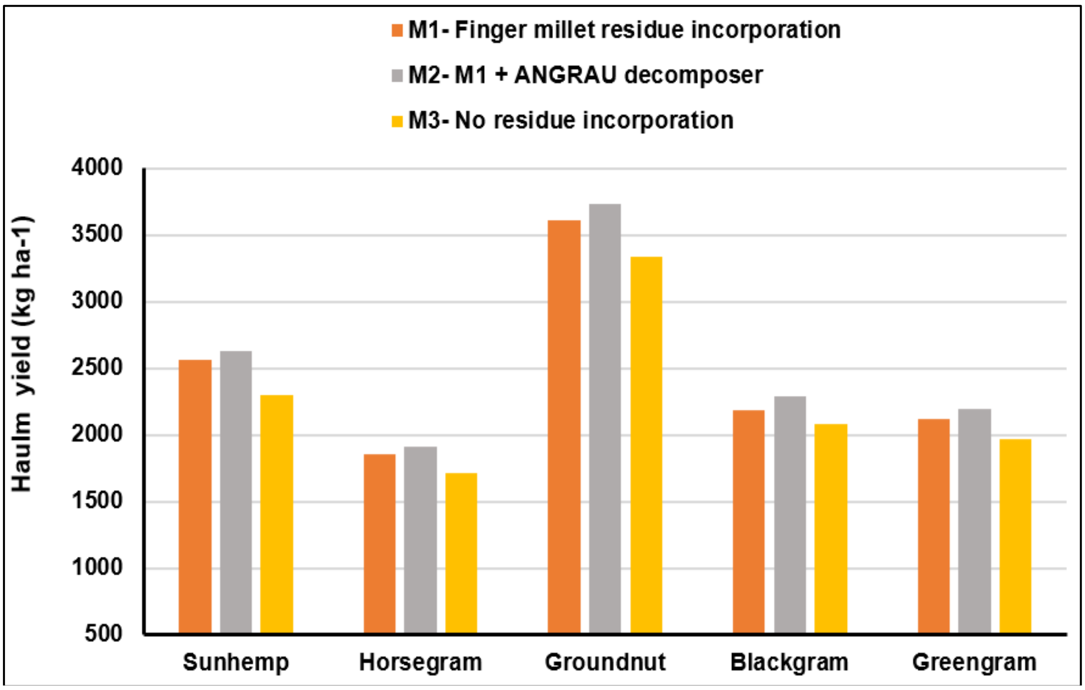

Fig. 2. Haulm yield (kg ha^{-1}) of various legume crops as influenced by finger millet residue management practices

3.2 Finger Millet Equivalent Yield (kg ha^{-1})

Finger millet equivalent yield (FMEY) of various legume crops was significantly influenced by residue management practices (Table.1). The highest mean FMEY was recorded under M_2 (residue incorporation + ANGRAU decomposer) (2075 kg ha^{-1}), which was on par with M_1 (finger millet residue incorporation) (1944 kg ha^{-1}) but significantly superior over M_3 (no residue incorporation) (1647 kg ha^{-1}). Among the crops, groundnut (S3) recorded significantly superior finger millet equivalent yield (3333 kg ha^{-1}), followed by sunhemp (S1) (1745 kg ha^{-1}). The equivalent yields of greengram (S5) (1600 kg ha^{-1}) and blackgram (S4) (1494 kg ha^{-1}) were on par with each other, whereas the lowest finger millet equivalent yield was recorded in horsegram (S2) (1273 kg ha^{-1}). Among the treatment combinations, groundnut with M_2 (Finger millet residue incorporation + ANGRAU decomposer) recorded the highest FMEY (3646 kg ha^{-1}), which was on par with groundnut with M1 (finger millet residue incorporation) (3481 kg ha^{-1}). Horsegram (S2) with no residue incorporation (M3) (1150 kg ha^{-1}) showed the lowest finger millet equivalent yield. The higher finger millet equivalent yield registered in groundnut was mainly due to high pod yields resulting from the incorporation of finger millet residue with decomposer inoculants (ANGRAU decomposer) and a higher market price. The yield enhancement with finger millet residue + ANGRAU decomposer might be attributable to more efficient breakdown of lignocellulose by microbial consortia, resulting in synchronised nutrient mineralisation and improved growth and yield components. Synergistic effect between crop residue + decomposer followed by legumes leads to rapid nutrient cycling, nitrogen fixation, translocation of assimilates from source to sink, and thereby supports crop phenological development, contributing to greater yields than individual practices alone. These findings align with Khamadi et al. (2017) and Latha et al. (2023), who reported improved yield components in legumes and cereals under crop residue incorporation with microbial decomposers.

3.3 Economics

The economics were evaluated based on prevailing market prices of inputs and outputs. The results clearly demonstrated that, the integration of finger millet residue incorporation with ANGRAU decomposer (M_2) produced superior economic returns compared to other treatments (Table. 2&3; Fig. 3). Among the residue management practices, M_2 recorded the highest gross returns, primarily due to increased yields across all crops, ranging from Rs.79,842 ha^{-1} in sunhemp to Rs. 1,50,079 ha^{-1} in groundnut. In contrast, no residue incorporation (M_3) consistently recorded the lowest gross returns due to reduced productivity. Among the legume crops, groundnut recorded the significantly highest gross returns (Rs.1,50,079 ha^{-1}) and net returns (Rs.91,844 ha^{-1}), which were followed by sunhemp (Rs.79,842 ha^{-1} and Rs. 40,916 ha^{-1}). Groundnut under M_2 produced significantly the highest gross and net returns (Rs.1,63,853 ha^{-1} and Rs.1,03,819 ha^{-1}), which were found at par with the same crop under M_1 (Rs. 1,56,551 ha^{-1} and Rs. 97,417 ha^{-1}). The lowest gross and net returns were recorded in horsegram under M_3 (Rs. 52,768 ha^{-1} and Rs.22,119 ha^{-1}).

Table 1. Effect of finger millet residue management practices on finger millet equivalent yield (kg ha^{-1}) of subsequent legume crops

Treatments	S_1 Sunhemp	S_2 Horsegram	S_3 Groundnut	S_4 Blackgram	S_5 Greengram	Mean M
M_1 – Finger millet residue incorporation	1830	1269	3481	1532	1610	**1944**
M_2 – M_1 + ANGRAU decomposer	2004	1399	3646	1601	1724	**2075**
M_3 – No residue incorporation	1399	1150	2871	1348	1467	**1647**
Mean S	**1745**	**1273**	**3333**	**1494**	**1600**	
	S.Em±	**CD (P=0.05)**	**CV (%)**			
Mainplot	44.0	173	9.0			
Subplot	49.5	144	7.9			

Treatments	S_1 Sunhemp	S_2 Horsegram	S_3 Groundnut	S_4 Blackgram	S_5 Greengram	Mean M
Interaction						
a) For two sub plots means at same level of main plot means	85.7	250	-			
b) For two main plots means at same (or) different level of sub plot means	88.4	280	-			

Table 2. Gross monetary returns (Rs. ha-1) as influenced by finger millet residue management practices and various legume crops.

Treatments	S1 Sunhemp	S2 Horsegram	S3 Groundnut	S4 Blackgram	S5 Greengram	Mean M
M1 – Finger millet residue incorporation	83653	58148	156551	70101	73290	88349
M2 – M1 + ANGRAU decomposer	91236	63817	163853	73273	78353	94106
M3 – No residue incorporation	64636	52768	129831	61982	66855	75214
Mean S	79842	58244	150079	68452	72833	
	S.Em (±)	**CD (p=0.05)**	**CV (%)**			
Mainplot	1964.2	7712	8.8			
Subplot	2155.7	6292	7.5			
Interaction						
a) For two sub plots means at same level of main plot means	3733.9	10898	-			
b) For two main plots means at same (or) different level of sub plot means	3874.5	12312	-			

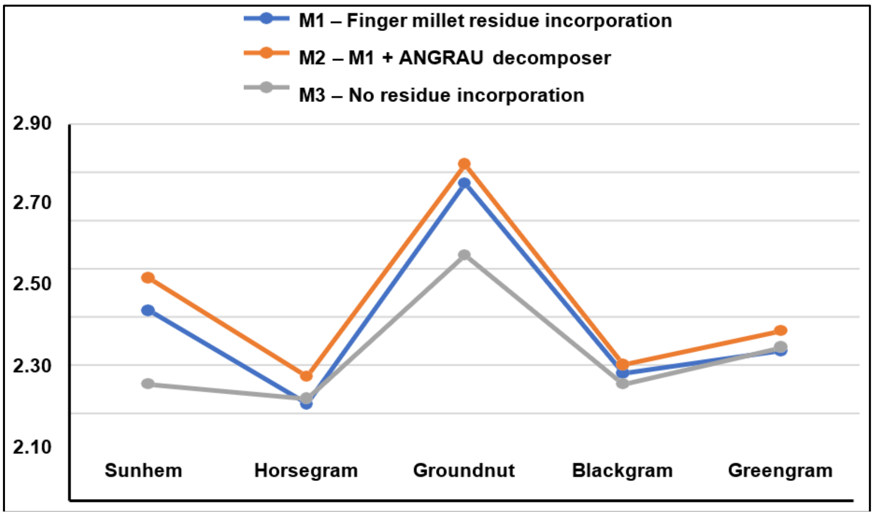

Fig. 3. Benefit-Cost ratio as influenced by finger millet residue management practices and various legume crops

Table 3. Net monetary returns (Rs. ha^{-1}) as influenced by finger millet residue management practices and various legume crops

Treatments	S1 Sunhemp	S2 Horsegram	S3 Groundnut	S4 Blackgram	S5 Greengram	Mean M
M1 – Finger millet residue incorporation	43825	23900	97417	31756	35245	46429
M2 – M1 + ANGRAU decomposer	50508	28668	103819	34028	39408	51286
M3 – No residue incorporation	28408	22119	74297	27237	32410	36894
Mean S	**40914**	**24896**	**91844**	**31007**	**35688**	
	S.Em (±)	**CD (p=0.05)**	**CV (%)**			
Mainplot	1964.2	7712	16.9			
Subplot	2155.8	6292	14.4			
Interaction						
a) For two sub plots means at same level of main plot means	3733.9	10898	-			
b) For two main plots means at same (or) different level of sub plot means	3874.5	12312	-			

Finger millet residue incorporation + ANGRAU decomposer (M_2) recorded the highest benefit cost ratio (2.13), which was found on par with M_1 (2.04) and significantly superior to M_3 (1.91) (Fig. 3). Among the legume crops, groundnut recorded the highest benefit-cost ratio (2.57) as compared to all other legumes; however, it was closely followed by sunhemp (2.04). The lowest benefit-to-cost ratio was recorded in horsegram (1.75). The enhanced profitability under M_2 is attributed to improved nutrient availability, microbial activity, and overall soil health, leading to increased yield and economic benefits. These results align with previous findings that emphasise the positive impact of integrating crop residues with microbial decomposers on productivity and economic returns in legume-based cropping systems (Gill & Singh, 2019) and Rajkumara et al*.* (2014).

3.4 Plant Nutrient Uptake (kg ha^{-1})

Finger millet residue management practices significantly influenced the nutrient uptake of succeeding legume crops (Table 4). Finger millet residue incorporation + ANGRAU decomposer exhibited higher uptake of nitrogen, phosphorus and Potassium; however, it was found on par with finger millet residue incorporation without decomposer. Residue removal led to the lowest nutrient uptake across all the crops. Among the legume crops, groundnut showed the highest uptake of nitrogen, phosphorus and potassium in the kernel (53.05, 12.49 and 10.76 kg ha^{-1}). Greengram registered the lowest grain nitrogen uptake (26.80 kg ha^{-1}). With regard to haulm nitrogen uptake, sunhemp exhibited the highest value (41.36 kg ha^{-1}), while horsegram showed the lowest (9.48 kg ha^{-1}). The haulm phosphorus uptake was significantly higher with groundnut (9.07 kg ha^{-1}), whereas the haulm potassium uptake was higher with green gram (33.07 kg ha^{-1}), sunhemp (32.16 kg ha^{-1}) and black gram (29.97 kg ha^{-1}). The increased nitrogen uptake under M_2 treatment could be attributed to enhanced decomposition and mineralisation processes facilitated by the microbial consortium in the ANGRAU decomposer, which improved nitrogen availability in ammonium and nitrate forms. Additionally, the Rhizobium species in the decomposer likely promoted biological nitrogen fixation, enhancing nitrogen accumulation in both grain and straw. These findings are supported by earlier studies conducted by Mubarak et al. (2003), Davari et al. (2012). Phosphorus uptake was significantly influenced by residue management practices. The improvement in phosphorus uptake is attributed to enhanced microbial activity from the decomposer application, facilitating solubilization of fixed phosphorus through organic acid production and phosphatases, thus increasing P availability to plants. These findings corroborate with Prabhakar et al. (2020); Kumawat et al. (2018). Residue incorporation enhanced potassium availability through exchange reactions where hydrogen ions released during decomposition displace potassium from soil colloids. This process, facilitated by microbial activity and organic acid production, improves potassium solubilization and uptake. These findings corroborate with Latha et al. (2023).

3.5 Soil Physico-chemical Properties

Soil physico-chemical properties were significantly influenced by finger millet residue management practices (Table 5). Although the effects on these properties were statistically non-significant, a slight improvement was observed across all parameters under residue incorporation, particularly with the application of ANGRAU decomposer (M_2), compared to no residue incorporation (M_3). Bulk density showed a slight reduction with M_2 (Finger millet residue incorporation + ANGRAU decomposer) (1.51Mg m^{-3}) and M_1(Finger millet residue incorporation) (1.53 Mg m^{-3}) as compared to M_3 (No residue) (1.55 Mg m^{-3}). Organic matter addition from finger millet residues might have enhanced the soil porosity and aggregation, while the microbial activity from ANGRAU decomposer further improved the soil structure. A marginal increase in soil pH was recorded with residue incorporation. The lowest pH was observed in M_2 (6.81), followed by M_1 (6.86) and M_3 (6.90). This slight rise might be due to the release of basic cations (Ca^{2+}, Mg^{2+}, K^+) during decomposition, which helped in neutralising the soil acidity. Yadvinder et al. (2004) also reported similar

Table 4. Effect of finger millet residue management practices on plant nutrient uptake of succeeding legume crops

Treatments	Nitrogen uptake (kg ha^{-1})		Phosphorus uptake (kg ha^{-1})		Potassium uptake (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw
Mainplots - Finger millet residue management practices (M): 3						
M_1 – Finger millet residue incorporation	34.21	29.00	6.68	6.72	7.90	27.66
M_2 – M_1 + ANGRAU decomposer	37.06	31.57	7.45	7.74	8.85	29.81
M_3 – No residue incorporation	27.79	24.88	4.96	4.83	5.90	23.76
S.Em (±)	0.79	0.30	0.21	0.23	0.26	0.90
CD (p=0.05)	3.10	1.17	0.82	0.90	1.03	3.52
CV (%)	9.30	4.10	12.90	13.90	13.50	12.80
Subplots - Legume crops (S): 5						
S_1 - Sunhemp	29.70	41.36	4.41	7.00	8.91	32.16
S_2 - Horsegram	27.18	9.48	6.66	5.12	4.62	15.45
S_3 - Groundnut	53.05	33.10	12.49	9.07	10.76	24.73
S_4 - Blackgram	28.37	31.90	4.27	5.78	6.82	29.97
S_5 - Greengram	26.80	26.58	3.99	5.18	6.64	33.07
S.Em (±)	1.06	1.03	0.24	0.22	0.27	1.12
CD (p=0.05)	3.10	3.01	0.70	0.63	0.79	3.28
CV (%)	9.70	10.90	11.40	10.10	10.80	12.50
Interaction						
a.For two sub plots means at same level of main plot means						
S.Em (±)	1.84	1.79	0.42	0.38	0.47	1.95
CD (p=0.05)	NS	NS	NS	NS	1.37	NS
b.For two main plots means at same (or) different level of sub plot means						
S.Em (±)	1.83	1.63	0.43	0.41	0.50	1.96
CD (p=0.05)	NS	NS	NS	NS	1.59	NS

Table 5. Soil physio-chemical properties as influenced by finger millet residue management practices and various legume crops

Treatments	EC (dS m^{-1})	pH	OC (%)	BD (Mg m^{-3})	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
Mainplots - Finger millet residue management practices (M): 3							
M_1 – Finger millet residue incorporation	0.20	6.86	0.48	1.53	235.2	30.7	323.1
M_2 – M_1 + ANGRAU decomposer	0.20	6.81	0.49	1.51	243.2	32.9	330.8
M_3 – No residue incorporation	0.21	6.90	0.47	1.55	216.6	26.2	299.8
S.Em (±)	0.005	0.078	0.007	0.045	5.16	0.94	6.08
CD (p=0.05)	NS	NS	NS	NS	20.3	3.7	23.9
CV (%)	9.8	4.4	5.2	11.4	8.6	12.3	7.4
Subplots - Legume crops (S): 5							
S_1 - Sunhemp	0.17	6.92	0.50	1.52	233.1	31.6	324.6
S_2 - Horsegram	0.15	6.80	0.48	1.54	226.8	28.7	319.7
S_3 - Groundnut	0.17	6.70	0.49	1.51	244.1	33.2	337.0
S_4 - Blackgram	0.19	6.95	0.48	1.54	228.3	27.4	305.3
S_5 - Greengram	0.19	6.89	0.46	1.55	226.1	28.7	303.0
S.Em (±)	0.007	0.079	0.017	0.043	4.36	1.19	5.82
CD (p=0.05)	NS	NS	NS	NS	12.7	3.5	17.0
CV (%)	10.4	3.5	10.3	8.5	5.6	12.0	5.5
Interaction							
a.For two sub plots means at same level of main plot means							
S.Em (±)	0.012	0.137	0.029	0.075	7.56	2.08	10.09
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS
b.For two main plots means at same (or) different level of sub plot means							
S.Em (±)	0.012	0.145	0.027	0.081	8.50	2.09	10.88
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS

findings with residue retention. Soil OC content improved slightly with residue incorporation. M_2 recorded the highest OC (0.49%), followed by M_1 (0.48%) and M_3 (0.47%). This improvement might be due to the contribution of organic residues and accelerated decomposition by the microbial decomposer, promoting carbon sequestration. Similar results were reported by Blanco-Canqui and Lal (2006) and Kumar et al. (2016).

Soil available nitrogen, phosphorus and potassium were highest in M_2: Finger millet residue incorporation + ANGRAU decomposer (243.2, 32.9, 330.8 kg ha^{-1}), followed by M_1: Finger millet residue incorporation (235.2, 30.7, 323.1 kg ha^{-1}) and lowest in M_3: No residue (216.6, 26.2, 299.8 kg ha^{-1}) (Table.5). Among the legume crops, groundnut recorded the highest available nitrogen, phosphorus and potassium (244.1, 33.2, 337.0 kg ha^{-1}), which was found on par with the sunhemp (233.1, 31.6, 324.6 kg ha^{-1}). Whereas, the lowest soil nitrogen, phosphorus and potassium were recorded with green gram. “The increase in soil nitrogen is attributed to enhanced mineralisation and microbial activity from residue incorporation and decomposer application”, as supported by Yadvinder et al. (2004) and Yasmeen et al. (2018). Enhanced phosphorus availability is linked to CO_2 production during residue decomposition, which aids solubilization of bound phosphorus, corroborating Billa (2023). “Increased soil available potassium might be due to ion exchange and release from clay lattices facilitated by organic acid production during residue decomposition”, similar to findings by Shui et al. (2007) and Ogbodo (2011).

4. CONCLUSION

From the experimental results, it was concluded that groundnut crop with finger millet residue incorporation along with or without ANGRAU decomposer produced significantly higher economic yield, profitability, plant nutrient uptake and soil available nutrients. Hence, this practice can be a viable strategy for enhancing soil fertility, system productivity, and profitability in upland conditions.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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