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Effect of finger millet residue management on the performance of succeeding crops

S Sadhana, U Triveni, B Rajendra Kumar and Y Sandhya Rani
Department of Agronomy, Acharya N G Ranga Agricultural University,
Agricultural College, Bapatla-522101, Andhra Pradesh, India

ABSTRACT

A field experiment was conducted during the *rabi* season of 2024-25 at the Agricultural Research Station, Vizianagaram to evaluate the influence of finger millet residue management on the performance of succeeding legume crops sunhemp, horsegram, groundnut, blackgram, and greengram. The study involved three main residue management treatments: finger millet residue incorporation (M_1), M_1 + ANGRAU decomposer (M_2), and no residue incorporation (M_3) as main plots and sunhemp (S_1), horsegram (S_2), groundnut (S_3), blackgram (S_4) and greengram (S_5). Legume yields were converted to finger millet equivalent yield (FMEY) for comparison. The incorporation of finger millet residue along with the ANGRAU decomposer (M_2) significantly improved plant growth, drymatter accumulation, phenological duration, yield attributes, and nutrient uptake across all crops, particularly groundnut. The treatment of M_2 recorded the highest finger millet equivalent yield (2075 kg ha^{-1}), followed by finger millet residue incorporation (M_1) (1944 kg ha^{-1}) and no residue incorporation (M_3) (1647 kg ha^{-1}). Groundnut exhibited the highest finger millet equivalent yield (3333 kg ha^{-1}), highlighting its suitability in millet-based systems. The study concludes that integrating crop residue with microbial decomposers enhances soil health, nutrient cycling, and productivity in millet-based cropping systems.

Keywords: *Decomposer, Finger millet residue, Legume crops and Productivity*

Agriculture in India, especially in upland and rainfed regions, remains the cornerstone of rural livelihoods and national food security. However, the sustainability of conventional cereal-based systems, particularly continuous rice cultivation, is increasingly threatened by declining soil fertility, low productivity, and climate-induced risks. These concerns are more acute in ecologically fragile upland areas characterized by water scarcity, degraded soils, and limited access to agricultural inputs.

Finger millet (*Eleusine coracana* L. Gaertn) emerges as a climate-resilient, nutrient-dense alternative suitable for low-input farming systems in these regions. Known as a "nutricereal," finger millet is rich in calcium, iron, dietary fiber, and methionine, a limiting amino acid in rice and wheat. Its grain is complemented by highly nutritious straw, which is high in organic matter and useful as livestock feed or a source of soil organic carbon. Despite its advantages, large quantities of finger millet straw are either burned or discarded, contributing to nutrient loss and environmental degradation. Efficient utilization of this biomass especially through *in-situ* residue incorporation or microbial decomposition could substantially improve soil structure, enhance nutrient cycling, and promote sustainable intensification of cropping systems.

Residue incorporation, when paired with legume-based cropping systems, offers an ecological intensification pathway by restoring soil organic matter, boosting nitrogen fixation, and reducing dependence on synthetic fertilizers. Legumes like greengram, blackgram, horsegram, and groundnut play a critical role in such systems by contributing to biological nitrogen fixation, enhancing microbial diversity, and improving overall productivity and sustainability. The present study was therefore undertaken to evaluate the impact of finger millet residue management particularly the use of ANGRAU decomposer on the growth, yield, and nutrient uptake of succeeding legume crops under upland conditions. The research aims to explore these practices influencing soil fertility, system productivity, and economic returns, thereby supporting more sustainable and resilient millet-based cropping systems.

MATERIAL AND METHODS

The present 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 site lies in the North Coastal Agro-climatic Zone of Andhra Pradesh (18°072 N latitude, 83°252 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 crop was transplanted at a spacing of 30 × 10 cm. 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 straw (5 t ha^{-1}) was chopped with a shredder and incorporated using a power weeder upto 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 straw application. A period of 30 days was left for complete decomposition of straw. After that, the land was prepared thoroughly with rotovator to a fine tilth. Legume seeds were sown manually. Crop-specific seed rates and recommended fertilizers were applied. Irrigation was given immediately after sowing and during critical growth stages. Pendimethalin was applied as pre-emergence herbicide for weed control. Crop-specific pest and disease management practices were adopted. Biometric data including plant height, dry matter accumulation, number of pods, branches, seeds per pod, test weight, grain and straw yields were recorded. Growth observations were taken at 30, 60, 90 DAS and at harvest, while post-harvest observations included grain yield, haulm yield, harvest index, and finger millet equivalent yield (FMEY) were also recorded. Finger millet equivalent yield (FMEY) was calculated using standard price-based conversion, and per-day productivity was derived by dividing the grain yield by the crop duration in days. 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 analyzed for nutrient content (N, P, K) and uptake was computed. The data were statistically analyzed 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.

RESULTS AND DISCUSSION

Growth Parameters

Finger millet residue management significantly influenced growth parameters across all five legume crops. The incorporation of finger millet residues, particularly when combined with ANGRAU decomposer (M_2), resulted in the tallest plant height and highest dry matter accumulation at all observed growth stages (30, 60, 90 DAS and harvest). For instance, sunhemp (S_1) recorded maximum plant height under M_2 (Finger millet residue incorporation + ANGRAU decomposer) with 156.8 cm at harvest which was 4.25% higher than M_1 (finger millet residue incorporation) and 10.89% higher than M_3 (no residue incorporation) as depicted in Fig.1. This trend was consistent in other crops such as in (S_3) groundnut under M_2 (Finger millet residue incorporation + ANGRAU decomposer) showed 6.23% higher plant height than M_1 (finger millet residue incorporation) and 24.4% higher than M_3 (no residue incorporation) as shown in Fig. 3. In blackgram, where M_2 (Finger millet residue incorporation + ANGRAU decomposer) outperformed M_3 (no residue incorporation) by 7.29% at harvest as shown in Fig. 4. Across all crops and growth stages, M_2 (finger millet residue incorporation + ANGRAU decomposer) recorded the highest dry matter accumulation. Sunhemp showed a 62.8% increase over M_3 (no residue incorporation) at harvest, horsegram showed up to 48.9% at 30 DAS, and groundnut reached 12.8% higher than M_3 (no reside incorporation). Blackgram and greengram also showed up to 35% more dry matter in M_2 (finger

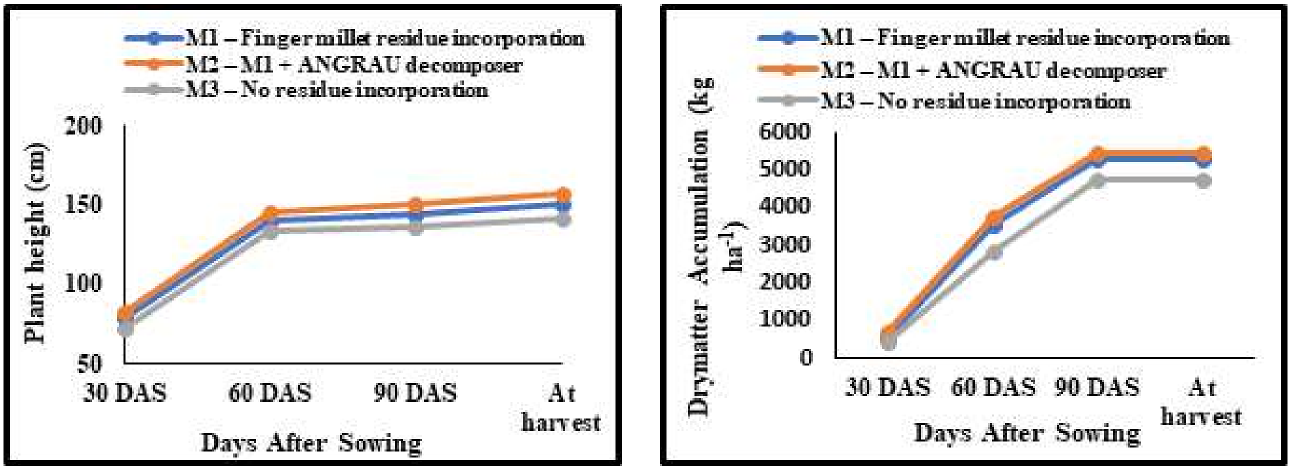

Fig. 1. Plant height (cm) and drymatter accumulation (kg ha^{-1}) of sunhemp at 30, 60, 90 DAS and at harvest as influenced by finger millet residue management practices

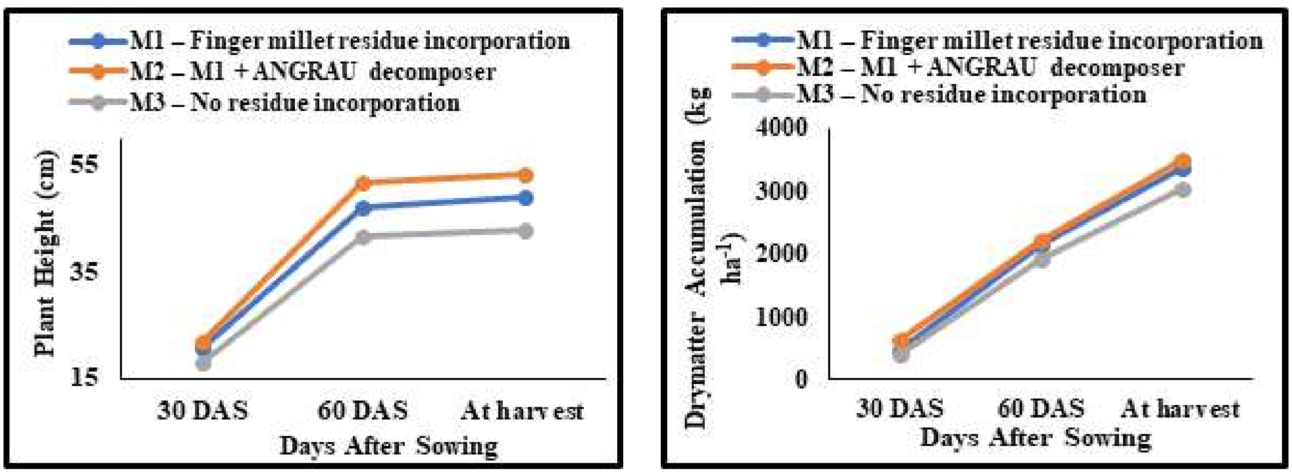

Fig. 2. Plant height (cm) and drymatter accumulation (kg ha^{-1}) of horsegram at 30, 60 DAS and at harvest as influenced by finger millet residue management practices

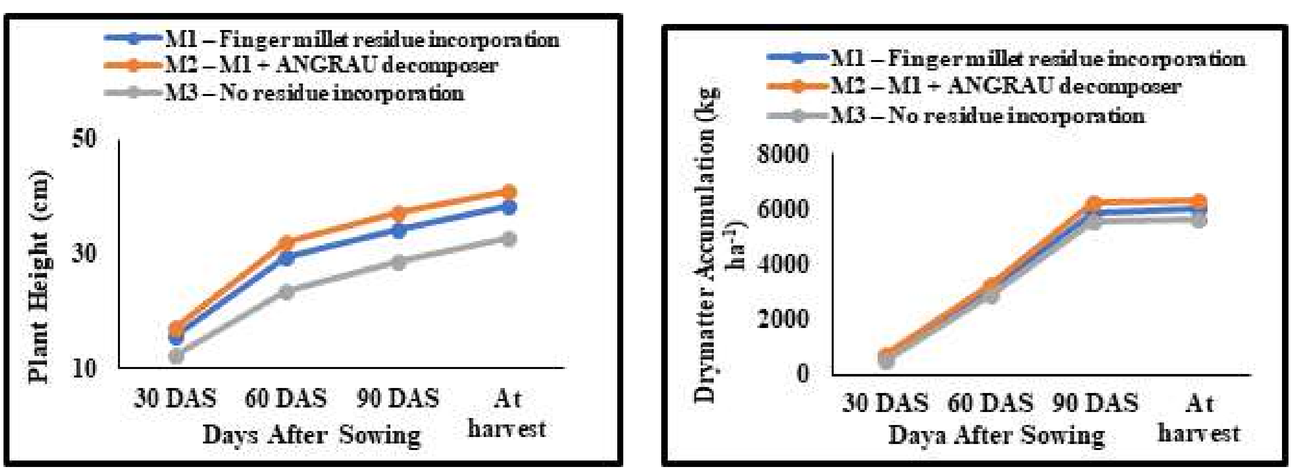

Fig. 3. Plant height and drymatter accumulation (kg ha^{-1}) of groundnut at 30, 60, 90 DAS and at harvest as influenced by finger millet residue management practices

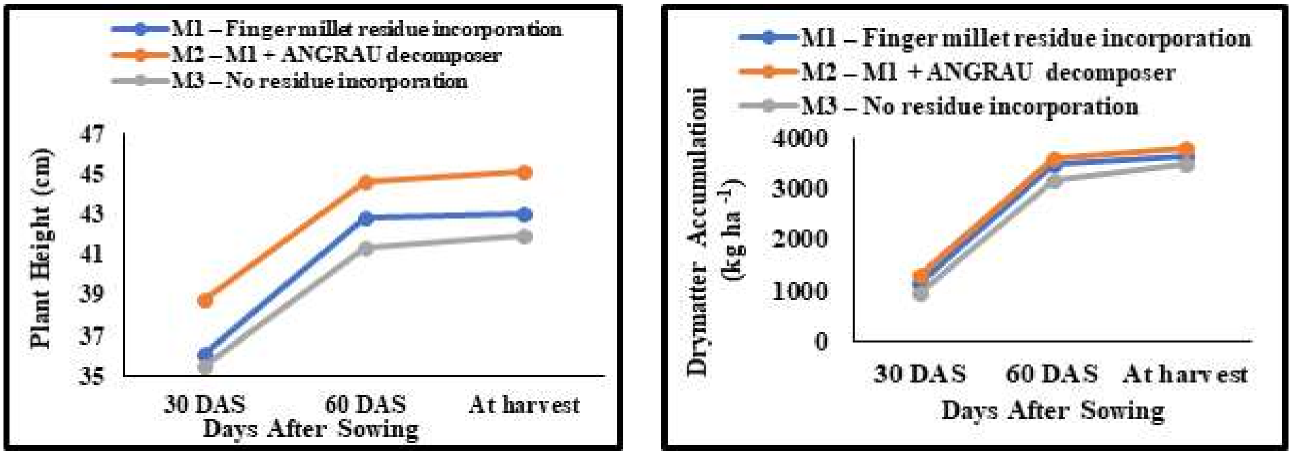

Fig. 4. Plant height and drymatter accumulation (kg ha^{-1}) of blackgram at 30, 60 DAS and at harvest as influenced by finger millet residue management practices

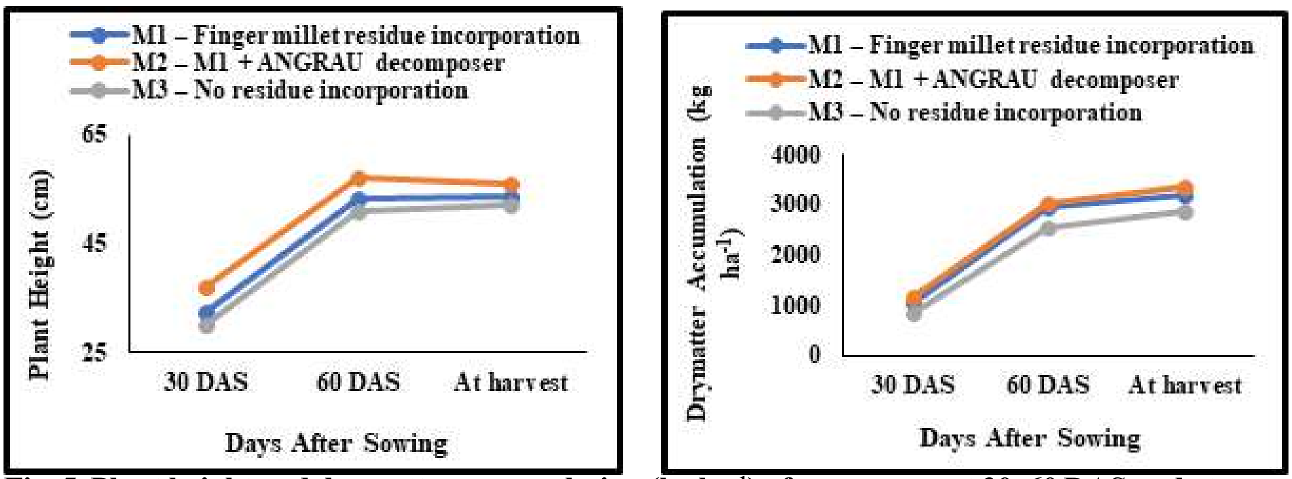

Fig. 5. Plant height and drymatter accumulation (kg ha^{-1}) of greengram at 30, 60 DAS and at harvest as influenced by finger millet residue management practices

millet residue incorporation + ANGRAU decomposer). This increase in plant height and biomass is attributed to accelerated decomposition of residues and enhanced nutrient release facilitated by microbial consortia in ANGRAU decomposer. *Trichoderma spp*., a key component, also produces phytohormones that stimulate plant growth. Similar findings were reported by Chowdappa *et al.* (2013) and Mukesh (2019). Also, previous studies showed that crop residue retention enhanced growth in various cropping systems (Dhar *et al.,* 2014 and Yasmeen *et al*., 2018). Similar observations were made by Meena (2015) and Blanco-Canqui & Lal (2006), who demonstrated increased plant biomass and height in groundnut and wheat under residue incorporation practices.

Grain Yield and straw yield

The effect of finger millet residue management practices were reflected in grain yield (Fig. 6). Groundnut recorded higher pod yield (2306 kg ha^{-1}) in M_2 (Finger millet residue incorporation + ANGRAU decomposer), 4.95% higher than M_1 (finger millet residue incorporation) and 14.7% higher than M_3 (no residue incorporation). Sunhemp (S_1) and horsegram (S_2) also recorded yield increase of 7.67%, 20.5% and 10.20%, 21.6%, respectively, in M_2 (Finger millet residue incorporation + ANGRAU decomposer) compared to M_1 (finger millet residue incorporation) and M_3 (no residue incorporation) respectively. Similarly, greengram and blackgram showed yield increase of 7.17%, 17.5% and 4.50%, 18.8%, respectively, under M_2 (Finger millet residue incorporation + ANGRAU decomposer) as compared to M_1 (finger millet residue incorporation) and M_3 (no residue incorporation) respectively. Davari *et al*. (2012) and Raghavendra *et al*. (2018) documented better pod formation and yield in mung bean through combined application of rice and wheat crop residues. Straw yield was significantly influenced by residue management practices. Across all crops, the highest straw yields were recorded under M_2 (finger millet residue incorporation + ANGRAU decomposer), followed by M_1, and the lowest in M_3 (no residue incorporation) depicted in Fig. 7. For instance, groundnut (S_3) produced a maximum haulm yield of 3730 kg ha^{-1} under M_2 (finger millet residue incorporation + ANGRAU decomposer), which was 3.44% and 11.9% higher than M_1 (finger millet residue incorporation) and M_3 (no residue incorporation) (3332 kg ha^{-1}) respectively. Similarly, sunhemp, horsegram, blackgram, and greengram under M_2 (finger millet residue incorporation + ANGRAU decomposer) also recorded increased haulm yields ranging from 2.53%, 2.58%, 4.85% and 3.34% higher over M_1 (finger millet residue incorporation) and 14.44%, 21.62 %, 18.82% and 17.5% higher over M_3 (no residue incorporation) respectively. The improvement is attributed to better plant growth and dry matter accumulation due to enhanced nutrient release and microbial activity. The enhanced productivity observed under M_2 (finger millet residue incorporation with ANGRAU

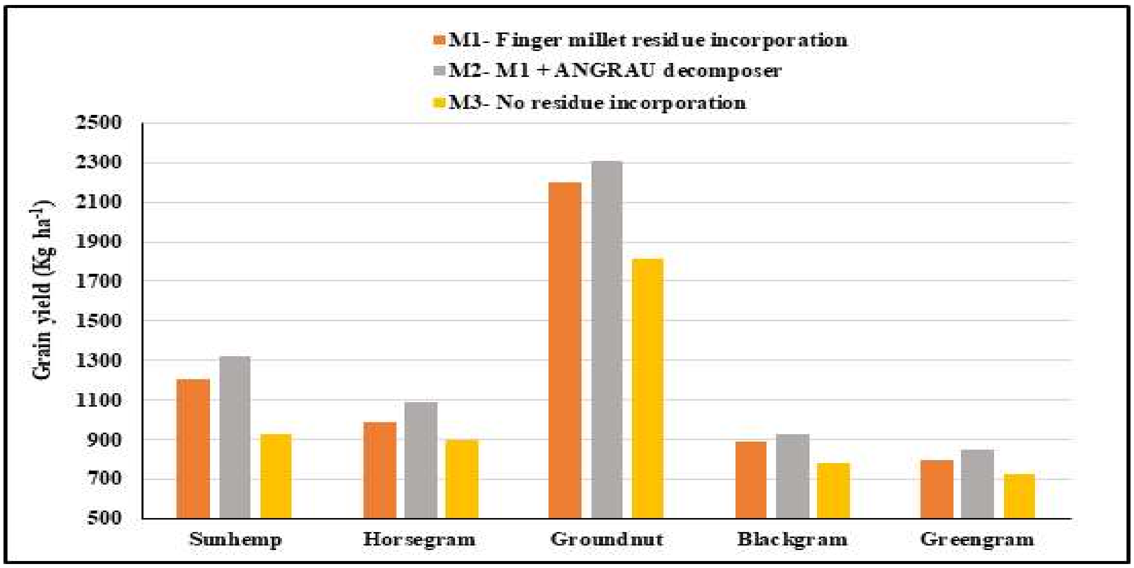

Fig. 6. Seed yield (kg ha^{-1}) of various legume crops as influenced by finger millet residue manage ment practices

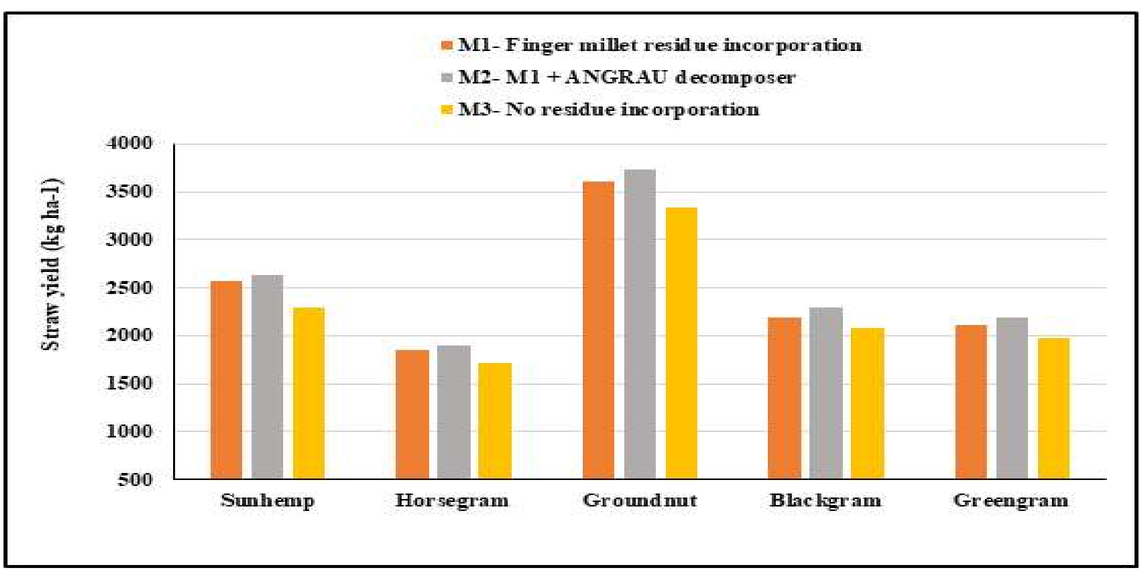

Fig. 7. Haulm yield (kg ha^{-1}) of various legume crops as influenced by finger millet residue management practices

decomposer) may be attributed to improved nutrient availability and increased microbial activity, resulting from the rapid decomposition of crop residues by the microbial consortium. These effects lead to better nutrient mineralization and uptake, promoting growth and yield. This finding aligns with Ratnam *et al*. (2023), who reported that foxtail millet residue combined with a bio-fertilizer consortium significantly improved Bengal gram productivity. Similar outcomes were documented by Piccoli *et al*. (2020).

Finger millet equivalent yield (kg ha^{-1})

Finger millet equivalent yield (FMEY) as indicated (Table 1.) was significantly influenced by both residue management practices and legume crops. The highest mean FMEY was recorded under M_2 (residue incorporation + ANGRAU decomposer) at 2075 kg ha^{-1} and was found statistically on par with M_1 (finger millet residue incorporation) with 1944 kg ha^{-1} and the lowest FMEY was recorded under M_3 (no residue incorporation) (1647 kg ha^{-1}). Among the legumes, groundnut recorded the highest FMEY (3333 kg ha^{-1}), with the combination of M_2 (Finger millet residue incorporation + ANGRAU decomposer) in groundnut (S_3) yielding the maximum finger millet equivalent yield (3646 kg ha^{-1}) and was found on par with M_1 (finger millet residue incorporation) in groundnut (S_3) (3481 kg ha^{-1}). 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.

Productivity (kg ha^{-1}day^{-1})

Per day productivity as indicated (Table 2) was significantly affected by residue management practices. The highest mean value was recorded under M_2 (finger millet residue incorporation + ANGRAU decomposer) at 13.83 kg ha^{-1} day^{-1} and was found statistically on par with M_1 (finger millet residue incorporation) (13.05 kg ha^{-1} day^{-1}), and the lowest in M_3 (no residue incorporation) (12.06 kg ha^{-1} day^{-1}). Among crops, groundnut (S_3) exhibited the highest

Table 1. Finger millet equivalent yield (kg ha^{-1}) and productivity (kg ha^{-1} day^{-1}) of various legume crops as influenced by finger millet residue management practices

Treatments	FMEY (kg ha^{-1})	Per day productivity (kg ha^{-1} day^{-1})
Mainplots- Finger millet residue management practices (M): 3		
M_1 – Finger millet residue incorporation	1944	13.05
M_2 – M_1 + ANGRAU decomposer	2075	13.83
M_3 – No residue incorporation	1647	12.06
SEm (±)	44	0.264
CD (p=0.05)	173	1.03
CV (%)	9	7.9
Subplots -Legume crops (S): 5		
S_1 - Sunhemp	1745	11.65
S_2 - Horsegram	1273	11.95
S_3 - Groundnut	3333	18.63
S_4 - Blackgram	1494	11.51
S_5 - Greengram	1600	11.18
SEm (±)	49.5	0.354
CD (p=0.05)	144	1.03
CV (%)	7.9	8.2
Interaction		
M X S	250	NS
S X M	280	NS

Table 2. Interaction effect of finger millet residue management practices and various legume crops on finger millet equivalent yield (kg ha^{-1})

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	173	9			
Subplot	49.5	144	7.9			
Interaction						
a) For two sub plots means at same level of main plot means	85.7	250	-			
a) For two main plots means at same (or) different level of sub plot means	88.4	280	-			

per day productivity (18.63 kg ha^{-1} day^{-1}), significantly outperforming other legumes. These results reflect the positive impact of residue incorporation and microbial activity on nutrient availability, which supports better daily biomass and yield accumulation. Similar findings were reported by Ali *et al.* (2021), who observed increased daily productivity in cotton following pearl millet residue retention.

CONCLUSION

The results conclusively show that finger millet residue incorporation combined with or without ANGRAU decomposer (M_2) in groundnut was found to be superior in terms yield attributes, yield and overall system productivity. This integrated approach boosts soil fertility, promotes nutrient mineralization, and improves crop yields thus offering a viable strategy for sustainable intensification of millet-based cropping systems.

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