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RESEARCH PAPER

# Nitrogen Rates Affect the Growth and Yield of Pearl Millet and Sorghum in Kiambu and Bomet Counties, Kenya

Drusilla Cherono[1]*, Mwende Ngie[1], James Mutegi[2] and Joseph Gweyi-Onyango[1]

[1]Department of Agricultural Science and Technology, Kenyatta University, Nairobi, Kenya
[2]African Plant Nutrition Institute, East Africa Office, Nairobi, Kenya

*Corresponding author: drussila291192@gmail.com (**ORCID ID:** 0009-0002-0794-5704)

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## ABSTRACT

Sorghum (*Sorghum bicolor*) and pearl millet *(Pennisetum glaucum)* play a vital role in food security and as livestock feed in arid and semi-arid regions due to their drought tolerance, early maturity, and low nutrient requirements. Despite their importance, yields in parts of Kenya remain low, largely due to sub-optimal nitrogen (N) management. This study assessed the effects of four nitrogen levels (0, 40, 80, and 120 kg N $ha^{-1}$) on the growth and yield of pearl millet and sorghum in Kiambu and Bomet Counties. A randomized complete block design with split plots was used, with crop species (sorghum and pearl millet) as main plots and nitrogen rates as subplots. The treatments were replicated three times. Data on plant height, tiller number, and grain yields were collected. Results showed a significant difference ($p < 0.05$) across nitrogen rates, crop species, and locations. Application of 120 kg N $ha^{-1}$ produced the tallest plants (163.7 cm in Kiambu and 168.7 cm in Bomet at Flowering). Pearl millet produced more tillers (up to 13 per plant) than sorghum at high nitrogen rates. Grain yield increased consistently with nitrogen application, with 120 kg N $ha^{-1}$ giving the highest yield at both sites. Interestingly, the yields for both sorghum and pearl millet were higher in Kiambu (KU) than in Bomet when not supplied with nitrogen fertilizers with yield differences for pearl millet between the two sites being 69% while the differences for the two sites for sorghum being 59%. The difference between non-fertilized treatment and highest N (120 kg $ha^{-1}$) for pearl millet in Bomet was 31 folds while for KU it was 13 folds. Conversely, yield differences between control and highest dose at Bomet was 30 folds for sorghum and 14 folds at KU. The impact of N fertilizer was tremendous in Bomet site as compared to Bomet site. These findings demonstrate that nitrogen availability strongly enhances the vegetative growth and yield potential of both crops but this is strongly dependent on the site and growth stages of growth. Both crops are adoptable to low N with Sorghum being suited to low N than while pearl millet. The study concludes that despite these crops being considered orphan crops, their demand for N is particularly higher than initially assumed and that 120 Kg $ha^{-1}$ was not the optimal amount.

## HIGHLIGHTS

- With climate change and burgeoning populations, more crop production with shift to Arid and Semi-Arid frontier with fragile conditions.
- Both Sorghum and Pearl millets have been considered to be orphan crops in Kenya and have been grown by smallholder farmers with low N fertilizations.
- The results show a linear increase in grain yields of both sorghum and pearl with increasing N without reaching the optimal level with minimal the amounts in the study.
- The study underscores the need for fertilizing these crops with N to avoid soil mining.

**Keywords:** food security, nitrogen fertilizer, nutrient mining, orphan crops, soil nutrition, tillering ability

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With climate change and upsurge in population, the need to move to marginal areas of Semi-Arid part of Kenya are proving to be increasingly crucial as important agricultural frontiers for food production and animal feeds as well as animal production. These regions have limited, erratic and short rains, necessitating a need for adaptable crops to these conditions (particularly drought and heat stress). Lately, drought stress has emerged as a major abiotic constraint, with agricultural productivity limited at regional and global levels (Santosh *et al.* 2024; Ranjan *et al.* 2025). Drought stress poses severe threat to crop yield and food security amid escalating climate variability (Zhao *et al.* 2023, Sagar *et al.* 2024; Chiang *et al.* 2021). The droughts episodes have direct impact on water availability to crops and hamper nutrient availability. Water deficit rapidly impairs key physiological processes, including photosynthesis, hydraulic conductance, and nutrient assimilation, disrupting the carbon–water–nitrogen (N) metabolic nexus and ultimately reducing crop performance (Zandalinas *et al.* 2018; Banerjee and Maitra, 2020; Jamal *et al.* 2025). Cereal crops, including rice, barley, wheat, sorghum, maize, corn, rye and pearl millets are $C_4$ plants and are more tolerant to water stress and efficient in water and nutrient utilization (Sharma *et al.* 2026; Seleiman *et al.* 2025).

Quantitatively, *Sorghum bicolor* (L) ranks as the world's fifth most important cereal grain after wheat, maize, rice and barley (Batista *et al.* 2019, Njinju *et al.* 2022; Gumo *et al.* 2025) with Africa being the largest producer of sorghum and this accounts for almost a third of the global production (Munda *et al.* 2019). Moreover, sorghum and pearl millet are considered as important cereal crops in Sub-Saharan Africa due to their resilience in harsh climatic conditions, including drought, heat, and low soil fertility (Chaturvedi *et al.* 2022). They serve as staple foods and livestock feeds in many rural households (Blummela *et al.* 2003). In Kenya, their production is increasingly crucial in addressing food insecurity, particularly in arid and semi-arid regions (Majeed *et al.* 2023). The low and erratic rainfall limit moisture and nutrient (such as phosphorus and particularly nitrogen) uptake with increasing attention being given to the interactions between specific elements, such as carbon, nitrogen and phosphorus, and their relationships with the SDGs (Zhou *et al.* 2026; Das *et al.* 2026). Among these goals, nitrogen is of particular importance (Schulte-Uebbing *et al.* 2022; Das *et al.* 2025). It acts as both an enabler and a constraint in achieving the SDGs, with its impacts spanning environmental, social, and economic dimensions. When used efficiently, nitrogen can catalyze progress across multiple goals (Zhou *et al.* 2026).

Whereas, Nitrogen (N) is commonly the most limiting nutrient for crop production in the majority of the world's agricultural areas, judicious application is quite important hence there is need to adopt good N management strategies that would naturally result in large economic benefits to farmers and also avoid environmental pollution, especially when applied is excess of plant demands or requirements (Krishna *et al.* 2024; Ray *et al.* 2025; Randy *et al.* 2026). On the other hand, too little would lead to mining of the soils (Masso *et al.* 2024). Indeed, fertilizer N has been reported to have immensely contributed more than any other fertilizer towards increasing yield and yield components of grain crops, including sorghum. Consequently, N has become the foremost input in relation to cost and energy requirement in advanced agricultural production systems (Ali *et al.* 2025; Maheswari *et al.* 2025; Pradhan *et al.* 2026). Therefore, from foregoing, there is no doubt that Nitrogen is one of the major inputs in crop production (Maitra *et al.* 2024; Sairam *et al.* 2025), particularly in sorghum pearl millet production, affecting both yield and quality through influencing those components which have great contribution in increasing grain yield of these crops.

Despite their inherent hardiness, sorghum and pearl millet productivity remains low in several counties such as Kenya. This is common in several areas, including Kenyatta University (KU) and Bomet, where declining soil fertility, especially nitrogen deficiency, is a major contributor to the low yield. Nitrogen is a key component of chlorophyll and amino acids, making it indispensable for vegetative growth, leaf area development, and biomass yield (Pandey *et al.* 2001).

Previous studies across Africa and Asia show that nitrogen fertilization significantly improves growth attributes such as plant height, dry matter accumulation, and the number of tillers, besides enhancing grain yield (Jakhar *et al.* 2011). However, Plant responses to nitrogen have shown to be

dependent on crop species, environment, soil fertility status, and rainfall distribution (Otieno *et al.* 2022). In Kenya, limited research has directly compared pearl millet and sorghum responses to nitrogen across contrasting agro-ecological conditions, such as Kiambu (high altitude, moderate rainfall) and Bomet (cooler, higher rainfall), leaving a clear gap in site-specific evidence.

This study, therefore, addresses this gap by evaluating how nitrogen rates affect the growth and yield of sorghum and pearl millet across two contrasting counties. The results are essential for determining site-specific nitrogen recommendations that can improve productivity and contribute to food security.

## MATERIALS AND METHODS

### Study area

The study was conducted at Kenyatta University farm in Kiambu County, which is 1720 m above sea level, with bimodal rainfall of 989 mm annually, and at Chesoen, Bomet County, which is 1980 m above sea level, with bimodal rainfall of 100–1500 mm annually. The soil is ferrasol and humic nitisol in Kiambu and Bomet counties, respectively. Composite samples at 0–30 cm depth were collected prior to planting for nutrient analysis.

### Experimental design

A randomized complete block design (RCBD) with split-plot arrangement was used. The main plot consisted of the two cereal crops, the Gadam variety of sorghum and the ICMV 221 variety of pearl millet. The subplots consisted of four nitrogen levels (0 kg N $ha^{-1}$, 40 kg N $ha^{-1}$, 80 kg N $ha^{-1}$, and 120 kg N $ha^{-1}$), and each treatment was replicated three times.

### Data collection

#### *Determination of growth parameters*

Data were collected at vegetative, flowering, and maturity stages. The growth parameters were plant height, number of tillers, shoot dry weight, and root dry weight. Plant height was measured from the base to the tip of the main shoot in centimeters for six tagged plants per plot. The number of tillers was counted for selected plants at each stage.

#### *Yield determination*

Threshed grains from experimental net plots were used to determine the total yield. At harvesting, the grain was threshed and dried in an oven at 60°C until the moisture content was 12%, then weighed to give total yield per plot size, which was extrapolated to give yields per hectare.

### Statistical Analysis

All data collected were subjected to ANOVA using R software version 4.0.2. Significant means were separated using Tukey's test at a significant level of 0.05.

## RESULTS

### Determination of growth parameters

The results from the present study showed that pearl millet, sorghum, and nitrogen application treatments had significant effects ($p<0.05$) on plant height, number of tillers, shoot dry weight, and root dry weight (Table 1).

**Table 1:** Plant height (cm) of sorghum and millet as affected by nitrogen rates in KU and Bomet

| Factor | Treatments | Ku | | Bomet | |
|---|---|---|---|---|---|
| | | PHV | PHF | PHV | PHF |
| **Fertilizer** | 120kgN | 143.50a | 163.66a | 146.66a | 168.86a |
| | 80KgN | 117.00b | 141.30b | 121.00b | 143.00b |
| | 40KgN | 100.16c | 132.06c | 103.33c | 132.83c |
| | 0KgN | 79.16d | 122.33d | 79.83d | 123.00d |
| **P - Value** | | **0.001** | **0.001** | **0.001** | **0.001** |
| **Crop** | Millet | 116.83a | 135.85b | 120.41a | 145.65a |
| | Sorghum | 103.08b | 134.75b | 105.00b | 147.28a |
| **P - Value** | | 0.001 | 0.01 | 0.001 | 0.001 |

*Means with the same letter are not significantly different at p=0.05. PHV – Plant height at vegetative stage, PHF – plant height at flowering stage, Ku – Kenyatta University, N – Nitrogen.*

At the flowering stage, sorghum and pearl millet documented the longest plant height of 145.65 cm and 147.28 cm, respectively, in Bomet County, while the shortest plant height of 116.83 cm and 103.08 cm was observed at the vegetative stage in pearl millet and sorghum, respectively, in KU. Plots supplied with nitrogen fertilizer displayed a positive increase in the plant height, as illustrated in Table 1. Pearl

millet consistently grew taller than sorghum at all nitrogen levels, where the tallest plants of 168.86 cm at flowering stage Bomet County were recorded at 120kg N $ha^{-1}$ while the shortest 79.83 cm and 79.16 cm were observed at 0kg N $ha^{-1}$ at vegetative stage in Bomet and Kiambu County respectively. Nevertheless, significant interactive effects ($p<0.05$) were observed between sorghum, pearl millet, and nitrogenous fertilizer on plant height (Table 2).

**Table 2:** Interactive effects between sorghum, millet and nitrogen rates on plant height (cm) Ku and Bomet

| | Ku | | Bomet | |
|---|---|---|---|---|
| **Treatments** | **PHV** | **PHF** | **PHV** | **PHF** |
| 120kgN Millet | 152.66a | 176.66a | 154.00a | 183.66a |
| 120kgN Sorghum | 134.33b | 150.66b | 139.33b | 154.06b |
| 80KgN Millet | 121.00c | 143.60c | 126.33c | 145.33c |
| 80KgN Sorghum | 113.00c | 139.00d | 115.66d | 140.66cd |
| 40KgN Millet | 104.00d | 134.00e | 108.33d | 134.46de |
| 40KgN Sorghum | 96.33de | 129.66f | 98.33e | 131.66ef |
| 0KgN Millet | 89.66e | 125.66g | 93.00e | 128.33g |
| 0KgN Sorghum | 66.66f | 117.66h | 68.66f | 119.00h |
| **P - Value** | **0.05** | **0.05** | **0.001** | **0.001** |

*Means with the same letter are not significantly different at p=0.05.*

*PHV – Plant height at vegetative stage, PHF – plant height at flowering stage, Ku – Kenyatta University, N – Nitrogen.*

Nitrogen fertilization of 120 kg N in pearl millet recorded the greatest plant height, 183.66 cm, in Bomet County at the flowering stage. As shown in Table 3, the pearl millet sorghum and nitrogen application rates exhibited a significant influence at ($p<0.05$) on the tiller counts.

## Yield and yield components of sorghum and pearl millet as affected by nitrogen rates

Pearl millet consistently produced more tillers than sorghum, with the highest tiller count of 6.66 noted at the vegetative stage in Bomet County. An initial increase in the number of tillers was observed with the supply of nitrogen fertilizers, reaching a maximum of 12.16 tillers at a nitrogen rate of 120 kg N at the vegetative stage in Bomet County.

**Table 3:** Number of tillers as affected by sorghum, millet and nitrogen rates in Ku and Bomet

| | | Ku | | Bomet | |
|---|---|---|---|---|---|
| **Factor** | **Treatments** | **NTV** | **NTF** | **NTV** | **NTF** |
| **Fertilizer** | 120kgN | 11.00a | 12.00a | 11.00a | 12.16a |
| | 80KgN | 5.83b | 7.33b | 6.16b | 8.16b |
| | 40KgN | 1.50c | 2.50c | 2.16c | 2.16c |
| | 0KgN | 0.00d | 1.50c | 0.33d | 0.83d |
| **P - Value** | | 0.001 | 0.001 | 0.001 | 0.001 |
| Crop | Millet | 5.50a | 6.58a | 5.58a | 6.66a |
| | Sorghum | 3.83b | 5.00b | 4.08b | 5.08b |
| **P - Value** | | 0.001 | 0.01 | 0.001 | 0.001 |

*Means with the same letter are not significantly different at alpha=0.05.*

*NTV – Number of tillers at vegetative stage, NTF – Number of tillers at flowering stage, Ku – Kenyatta University.*

**Table 4:** Interactive effects between sorghum, millet and nitrogen rates on the number of tillers Ku and bomet

| | Ku | | Bomet | |
|---|---|---|---|---|
| **Treatments** | **NTV** | **NTF** | **NTV** | **NTF** |
| 120kgN Millet | 12.00a | 13.00a | 12.33a | 13.00a |
| 120kgN Sorghum | 9.66b | 11.00b | 10.00b | 11.33b |
| 80KgN Millet | 7.66c | 8.66c | 7.33c | 10.00c |
| 80KgN Sorghum | 4.33d | 6.00d | 4.66d | 6.33d |
| 40KgN Millet | 2.00e | 2.33e | 2.33e | 3.00e |
| 40KgN Sorghum | 1.00ef | 2.00ef | 2.00e | 2.00ef |
| 0KgN Millet | 0.00f | 1.00fg | 0.66f | 2.00ef |
| 0KgN Sorghum | 0.00g | 0.66g | 0.00f | 1.00f |
| **P - Value** | **0.05** | **0.05** | **0.05** | **0.01** |

*Means with the same letter are not significantly different at alpha=0.05.*

*NTV – Number of tillers at vegetative stage, NTF – Number of tillers at flowering stage, Ku – Kenyatta University.*

Moreover, significant differences were observed in the interaction between sorghum pearl millet and nitrogen fertilizer application on tiller counts, as displayed in Table 3. Pearl millet in both Counties produced the highest number of tillers, 13.00 at the flowering stage.

The yield parameter was significantly affected ($p < 0.05$) by pearl millet, sorghum, and nitrogen fertilizer application, as displayed in Table 5.

**Table 5:** Yield (t/ha) as affected by sorghum, millet and nitrogen rates in Ku and Bomet

| | | Ku | Bomet |
|---|---|---|---|
| **Factors** | **Treatments** | **Yield t/ha** | **Yield t/ha** |
| **Fertilizer** | 120kgN | 2.81a | 2.52a |
| | 80KgN | 1.63b | 0.97b |
| | 40KgN | 0.82c | 0.59c |
| | 0KgN | 0.49d | 0.31d |
| **P - Value** | | 0.001 | 0.001 |
| **Crop** | Sorghum | 1.58a | 1.38a |
| | Millet | 1.10a | 0.82b |
| **P - Value** | | 0.001 | 0.001 |

*Means with the same letter are not significantly different at alpha=0.05.*

*Key: ku – Kenyatta University.*

**Table 6:** Interactive effects between sorghum, millet and nitrogen rates on yield (t/ha) in Ku and Bomet

| | Ku | Bomet |
|---|---|---|
| **Treatments** | **Yield t/ha** | **Yield t/ha** |
| 120kgN Sorghum | 3.39a | 2.83a |
| 120kgN Millet | 2.26b | 1.64b |
| 80KgN Sorghum | 1.81c | 1.26c |
| 80KgN Millet | 1.14d | 0.69d |
| 40KgN Sorghum | 0.84e | 0.36e |
| 40KgN Millet | 0.39f | 0.13f |
| 0KgN Sorghum | 0.22g | 0.09g |
| 0KgN Millet | 0.16h | 0.05h |
| **P - Value** | **0.001** | **0.001** |

*Means with the same letter are not significantly different at alpha=0.05.*

*Ku – Kenyatta University.*

Comparison of pearl millet and sorghum, sorghum produced the maximum yields of 3.39 t/ha in Kiambu county, compared to pearl millet which produced 2.26t $ha^{-1}$. On the contrary, the highest grain yield for sorghum was 2.83t $ha^{-1}$ while for pearl millet it was 1.64 t $ha^{-1}$ in Bomet (Table 6). Grain yields increased linearly with increasing nitrogen fertilizer rates across all treatments. The plants that received the highest level of nitrogen fertilizer, 120 kgN, showed a greater increase in grain yields, 2.81 t/ha, than those that received lower levels, 40 kgN and non-fertilized (0KgN), which accumulated low yields of 0.59 t/ha and 0.31 t/ha, respectively, in Bomet County. The response of yields to interactions among pearl millet, sorghum, and nitrogen nutrition was significant ($p<0.05$), as illustrated in Table B. Nitrogen-fed sorghum at 120 kg N recorded the maximum grain yield of 3.39 t/ha in Kiambu County. However, the lowest grain yield, 0.05 t/ha, was observed for pearl millet in Bomet County under treatments without nitrogen application.

## DISCUSSION

### Determination of growth parameters

Increasing nitrogen fertilization rates caused significant effect in many growth attributes of pearl millet (Table 1) as well as forage yield such as plant height at the rate of 80 kg and N/ha. Similar findings have previously been reported at 80 kg $ha^{-1}$ (El-tilib *et al.* 2006), 90 kg N/fed (Sagar *et al.* 2022; Maitra *et al.* 2025), 100 kg N/ha, (Puri and Tiwana, 2005), and 180 kg N/ha (Ayub *et al.* 2009) and (Pathan *et al.* 2010). Despite Pearl millet being considered as orphan crop and hence receiving minimal attention in terms of nutrient application, the above findings are true testimony to its need to N fertilization. Abera *et al.* (2020) reported similar increase in heights with nitrogen with sorghum where the trends in increase in heights were commensurate with increase in N rates, meaning the highest amount of 92 kg $ha^{-1}$ was not the optimal value. Independent of N treatment, Chaturvedi *et al.* (2022) showed in a multi-location field study that sorghum genotype-by-trait biplots indicated that grain (GY) is highly influenced by flowering time, 100-grain weight (HGW), and plant height (PH). In the current study, we also report that treatment with greatest height had highest yield (Abera *et al.* 2020).

Nitrogen is the most consumed element by plants, and it plays a vital role in assimilation and transfer to growing organs (Fathi & Zeidali, 2022). It is one of the crucial nutrients for crop growth and development and needs to be sufficiently supplied for healthy plant growth (Fathi & Zeidali, 2022). Increased plant height in the current study (Tables 1 and 2) due to increased nitrogen fertilizer could be due to the role of N fertilizer, as reported to improve growth, elongation metabolism, internodes, photosynthesis, and assimilation production in rice (Jahan *et al.* 2022). Similar findings are supported by Shah *et al.* (2022), who stated that enhanced plant height with nitrogen nutrition in pearl millet is attributed to increased assimilation production

and photosynthesis. They also reported that N fertilization leads to enhanced cell division and expansion, thus causing increased plant height. Similarly, Aboelgoud *et al.* (2021) showed that more nitrogen application increased assimilation production and crop photosynthesizing area, thereby triggering plant height. In line with these results, Teshome *et al.* (2023) reported that N fertilizer application enhanced the plant height of sorghum in Ethiopia, and Joshi *et al.* (2020) also specified significant effects of nitrogen fertilizer on sorghum plant height. The findings of this study also noted that the plots with lower or without nitrogen fertilizer amendments experienced minimum plant height compared to the treated plots (Tables 1 and 2). This could be attributed to the plots lacking enough nitrogen fertilizer or to nutrient inaccessibility to crops. This is in agreement with Fathi & Zeidali (2022), who specified that nitrogen deficiency in crops causes adverse effects on crop production and delayed phenological growth. Further, Teshome *et al.* (2023) confirmed the effects of nitrogenous fertilizer on sorghum growth.

An increased nitrogen fertilizer rate significantly increased the tiller count of sorghum and pearl millet. These findings could be attributed to the effects of nitrogen fertilization in promoting the development of sorghum and pearl millet. Also, the enhanced number of tillers with a higher rate of nitrogen fertilizer could be due to the increased availability of nitrogen, which played a major role in cell division (Jahan *et al.* 2022). Moreover, these results are in agreement with Aboelgoud *et al.* (2021), who stated that nitrogen nutrition can promote leaf index area, enabling crops to produce a greater number of tillers. Where the number of tillers showed further increase with N application in our study, Shahin *et al.* (2013) showed a decreasing number of tillers after 60-70 kg $ha^{-1}$) application rate, this could be attributed to varieties used, form of N and inherent soil fertilizer that could set other factors such as other nutrient to be limiting to further tillering. Luo *et al.* (2020) reported on cotton that nitrogen promotes the synthesis of proteins involved in cell wall development, cell proliferation, and vegetative development. Melak *et al.* (2024) also concurred with the current study results, noting that increasing rates of N fertilization enhanced the maximum number of tillers, unlike treatments with low or no nitrogen. Besides, Sun *et al.* (2020) indicated that an adequate supply of nitrogen fertilizer in the correct amount improves dry matter accumulation, vegetation growth, and cell enlargement in cotton. In rice, Khan *et al.* (2021) reported increased tiller counts due to increased nitrogen fertilizer application, and Alhammad *et al.* (2023) revealed that N application enhanced tiller count, which could be due to nitrogen promoting cell division. Nevertheless, a gradual decline in tiller count was observed as the rate of nitrogen fertilization decreased (Tables 3 and 4). This was in line with Kumar *et al.* (2022), who demonstrated that deficient nitrogen fertilization caused low crop growth and development, which may have inhibited cell growth and blocked plant vegetative progress.

The application of different nitrogen rates had a significant impact on the aboveground biomass yield of sorghum and pearl millet (Tables 5 and 6). Sorghum and pearl millet shoot dry biomass increased significantly with nitrogen fertilizer because nitrogen enhanced crop growth, leading to greater dry biomass accumulation. This outcome was consistent with Alhammad *et al.* (2023) who reported the highest shoot biomass yield of rice after increased nitrogen application. The constant fertilizer effects on shoot dry biomass yields could be attributed to nitrogen influence and stimulated shoot biomass accumulation turnover (Keller *et al.* 2023). Likewise, Wodaje *et al.* (2024) found that the maximum shoot biomass yields in sorghum were noted on treatments supplied with nitrogen nutrition. Feng *et al.* (2023) concluded that increased nitrogen fertilizer promotes biomass allocation to vegetative organs. Similarly, Gebrekorkos *et al.* (2017) achieved high aboveground biomass in sorghum after nitrogen fertilization. Roots are vital structures that support the synthesis of many physiological substances, which are significant in the expansion and progress of plants (Xiong *et al.* 2021). The material exchange and information in the root system directly affect the development and growth of the plants (Fan *et al.* 2020).

## Yield determination

Nitrogen nutrition plays a vital role in crop yields as seen in the results of the current study (Tables 9 and 10). In this study, high rates of nitrogen fertilizer enhanced the crops to uptake and transfer

the mineral throughout the crop, resulting in high yields. This is attributed to the essential role of N in enhancing vegetative growth (Thakor *et al.* 2018). Also, it could be due to the remobilization of nutrient N, which enhances cell division and elongation, and cytokinin activates crops, causing higher growth and yields, which leads to high production (Shiade *et al.* 2024). Further, it could be due to nitrogen absorption by the plants that stimulated more biomass accumulation, root growth, and development, and grain yield (Fathi & Zeidali, 2022). The present study agrees with Abed's (2018) study on maize, which concluded that nitrogen fertilizer stimulated growth in the number of grain weight and grain in the ear, hence increased grain yields. Likewise, the treatment effects were explained by Degu *et al.*'s 2021 study in sorghum that stated that nitrogen fertilization in crops improves total crop yields. The results of the study are also in line with Bramhaiah *et al.* (2018) findings on grass, which showed that nitrogen fertilizer consumption and assimilation led to high forage weight per plant. In the same way, Aboelgoud *et al.* (2021) and Sarah *et al.* (2022) confirmed improved yields due to increased nitrogen fertilizer levels. Moreover, Alhammad *et al.* (2023) study on rice supported the outcome of the present study, adding that the appropriate use of nitrogen elements in plants significantly increases crop yields.

Lack of sufficient nitrogen fertilizer decreases crop yields, as indicated in the sorghum and pearl millet used in this study (Tables 9 and 10), and this highlights the importance of nitrogen nutrition. The plots without N amendment recorded the greatest yield loss in this study, which could be attributed to a deprived nutrient supply to the plant due to a deficiency in the soil, which was not enough to satisfy the nutrient demands of the two crops used in the experiment. The results in the study are associated with Habtemariam *et al.*'s (2023) study, which shows nitrogen as the definitive yield-limiting mineral for maize production. Getu *et al.* (2020) study also enlightened nitrogen as one of the major nutrients that mostly limit crop yields globally.

## CONCLUSION

Generally, this study concludes that Crop yield and Growth of sorghum and pearl millet significantly increased with increased N application. Supply of nitrogen nutrients to the crops stimulated above-ground biomass, below-ground biomass, and yield of pearl millet and sorghum. Sorghum performed better in yield and biomass accumulation, while millet demonstrated higher nitrogen uptake and nutrient use efficiency. Subsequently, the recommended nitrogen fertilizer application rate for optimum production of sorghum and pearl millet is 120kg/ha.

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