**Original Research Article**

**Yield Response of Onion (Allium cepa L.) to Integrated Application of Inorganic (NPS/Urea) and Organic Fertilizers at Fafan Research Center, Somali Region, Ethiopia**

**ABSTRACT**

*Onion (*Allium cepa *L.) is an economically important vegetable in Ethiopia, especially in irrigated areas like the Somali Region. However, its productivity remains low due to declining soil fertility and poor nutrient management. This study was conducted during the 2023/2024 cropping season at the Golajo site of the Fafan Agricultural Research Center to evaluate the effects of integrated nutrient management on the growth and yield of onion. A field experiment was laid out in a randomized complete block design (RCBD) with three replications, testing factorial combinations of three NPS/urea fertilizer rates (0, 50/50, 100/100, and 150/150 kg/ha) and three farmyard manure (FYM) levels (0, 10, and 20 t/ha). The onion variety ‘Hadramout’ was used. Results showed that both NPS/urea and FYM significantly influenced phenological traits, growth parameters, and yield components. The highest plant height (64.78 cm), leaf number (15.58), leaf length (55.13 cm), and average bulb weight (135.3 g) were recorded with the highest combined fertilizer rates. The maximum total bulb yield (17.34 t/ha) and marketable yield (17.21 t/ha) were also obtained under this treatment. Conversely, control plots without fertilizer showed the lowest values across most parameters. The findings highlight the importance of integrated nutrient management in enhancing onion productivity and suggest that combining 150/150 kg/ha of NPS/urea with 10–20 t/ha of FYM is an effective strategy. To validate these findings, additional trials across multiple locations and seasons are recommended. The integrated use of organic and inorganic fertilizers offers a sustainable strategy for enhancing soil fertility, increasing crop yield, and improving farm profitability.*

***Key words:***Farmyard manure, Integrated nutrient management, Onion (Allium cepa L.), Yield components,

**INTRODUCTION**

Onion (Allium cepa L.) is a member of the genus Allium within the family Alliaceae (Boukary et al., 2012). It stands out as one of the most widely cultivated and economically important vegetable crops globally (Maria and Roman, 2009; Hamma et al., 2013). Onions are among the richest dietary sources of flavonoids, compounds linked to a lower risk of cancer, cardiovascular disease, and diabetes. Worldwide, the cultivation area for onions is expanding because of their high profitability per unit area and relatively simple cultivation (FAO 2011).

Despite this growth, the productivity of onion in Ethiopia remains below potential. The national average yield is 8.9 t/ha, while in the Somali Region particularly in the Fafen zone it drops to just 5.39 t/ha (CSA, 2021). This yield gap is largely attributed to declining soil fertility and poor nutrient management. Factors such as extensive nutrient depletion, low fertilizer use efficiency, and limited adoption of sustainable soil management practices have further exacerbated the issue (ATA, 2014; Hailu et al., 2015).

Onion production in Ethiopia faces several challenges, with key issues including imbalanced fertilizer use, incorrect application rates, and poor soil fertility management practices, compounded by farmers' limited knowledge in this area (Gebretsadik and Dechassa 2016; Negasi et al. 2017). The prolonged application of inorganic fertilizers without integrating organic matter often leads to micronutrient deficiencies and deteriorates the physical and chemical properties of the soil, ultimately threatening sustainable crop production (Gupta et al. 1999; Yohannes et al. 2017). Incorporating organic materials into the soil can enrich it with essential nutrients, enhance nutrient uptake by crops, and potentially boost yields (Shaheen et al. 2007).

Integrated nutrient management combining organic and inorganic sources is increasingly recognized as a sustainable strategy to improve productivity, maintain soil health, and reduce environmental impacts (Singh et al., 2010; Javariaa and Khan, 2011).

However, limited research has been conducted to evaluate optimal nutrient combinations specifically for onion in Gursum district. This study seeks to address this gap through integrated fertilizer trials.

**2. MATERIALS AND METHODS**

The field experiment was conducted at Golajo site of the Fafan Agricultural Research Center, located in the Fafan Zone of the Somali Region. The objective was to assess the effect of integrated application of organic and inorganic fertilizers on onion yield and soil properties. The onion variety 'Hadramout, which is widely grown and accepted in the region, was used as the test crop. The fertilizers applied included NPS (19% N, 38% P₂O₅, 7% S), urea (46% N), and composted farmyard manure.

The treatments consisted of a factorial combination of three rates of urea/NPS (0, 50/50, 100/100, and 150/150 kg ha⁻¹) with three rates of compost (0, 10, and 20 t ha⁻¹). The experiment was conducted using a randomized complete block design (RCBD) with three replications. Each plot measured 3 meters by 2.4 meters (7.2 m²) and contained 8 single rows arranged as 4 double rows. The spacing between blocks and plots was maintained at 1.5 meters and 1 meter, respectively. Seedlings were first raised in a nursery and then transplanted at the 3–4 leaf stage, 45 days after sowing. Transplanting followed the recommended spacing: 40 cm between furrows, 20 cm between rows on ridges, and 10 cm between plants.

Fertilizer application involved full dose of NPS at transplanting and split application of urea at 3 and 6 weeks after transplanting. Compost was incorporated into the soil a week before transplanting. Standard agronomic practices, including irrigation, weeding, and pest control, were followed as per local recommendations. The crop was harvested when 80% of the leaves turned yellow and tops had fallen, indicating physiological maturity.

**2.2 Data Collection and Analysis**

Agronomic data collected included both crop phenology and yield-related parameters. Days to maturity were recorded as the number of days from transplanting to 80% physiological maturity. Growth measurements such as plant height, number of leaves per plant, and leaf length were taken from ten randomly selected plants. Yield components assessed included bulb diameter, neck diameter, average bulb weight, marketable and unmarketable bulb yield, and total bulb yield. Marketable bulbs were defined as those weighing 20–160 g and free of damage, while unmarketable bulbs were either undersized, oversized, diseased, or deformed.

All collected data were subjected to analysis of variance (ANOVA) using the SAS software (SAS Institute, 1998) under the GLM procedure. Significant differences among treatment means were compared using the Least Significant Difference (LSD) test at a 5% probability level.

 **3.Results and discussion**

**3.1 Phenological and Growth Parameters**

**Day to 90% maturity:**

The number of days required for onion plants to reach 90% maturity was significantly influenced by the individual application rates of NPS/urea and farmyard manure (FYM) at the 1% probability level (P < 0.01). Additionally, their combined interaction had a statistically significant effect at the 5% level (P < 0.05). The earliest maturity, at 110.7 days, was observed in plots that received no NPS/urea or FYM, while the latest maturity, at 121 days, was recorded in plots treated with the highest application rates of both fertilizers (150/150 kg NPS/urea ha⁻¹ and 20 t FYM ha⁻¹). These findings are consistent with previous studies by Girma (2011) and Negasi et al. (2017). The delayed maturity associated with higher fertilizer levels may be attributed to increased vegetative growth promoted by nitrogen and organic matter before the initiation of bulb formation.

Table 1. Days to 90% maturity of onion as influenced by the interaction of NPS/urea and FMY rates.

|  |
| --- |
| NPS/urea rate kg ha-1 |
| Farmyard manure t/ha | 0/0 | 50/50 | 100/100 | 150/150 |
| 0 | 110.7a | 112.3b | 114.0c | 115.7de |
| 10 | 111.0a | 113.7c | 115.3d | 116.7e |
| 20 | 113.3bc | 115.3d | 118.0f | 121.0g |
| LSD (0.05) |  |  | 1.206 |  |
| CV (%) |  |  | 0.6 |  |

**Plant Height(cm)**

Plant height was significantly influenced by the main effects of NPS/urea and farmyard manure (FYM) application rates at the 1% significance level (P < 0.01), while their interaction had no significant impact. The tallest plants (59.69 cm) were observed with the application of 20 t FYM ha⁻¹, whereas the shortest plants (56.71 cm) were recorded in plots with no FYM application (0 t ha⁻¹) (Table 2). Similarly, plant height increased progressively from 50.87 cm to 64.78 cm as the NPS/urea rate increased from 0/0 to 150/150 kg ha⁻¹ (Table 4). These findings are consistent with the studies conducted by Kokobe et al. (2013), Gererufael et al. (2020), and Yohannes et al. (2017). The observed increase in plant height with higher fertilizer rates can be attributed to the essential role of nutrients in promoting photosynthesis, enhancing cell division and elongation, and stimulating overall vegetative growth.

**Leaf number per plant**

Leaf number was significantly influenced by the main effects of NPS/urea and farmyard manure application rates at the 1% level (P < 0.01), although their interaction was not significant. The highest average number of leaves per plant (15.58) was recorded at the highest NPS/urea rate of 150/150 kg ha⁻¹, while the lowest (10.54) occurred in the control plots without fertilizer application (Table 2). The increase in leaf production with higher fertilizer rates is likely due to the vital roles of nutrients such as nitrogen and phosphorus in supporting root and shoot development. Similar results were reported by Kokobe et al. (2013), who recorded the highest number of leaves (15.44) with the application of 150 kg N ha⁻¹ and 45 t FYM ha⁻¹, whereas the lowest leaf count was observed in the control treatment.

Table 2. Growth parameters of onion as influenced by the main effects of NPS/urea and FMY rates

|  |  |  |
| --- | --- | --- |
| **Treatment** | **Plant height (cm)** | **Leaf number per plant** |
| FYM t ha-1 |  |  |
| 0 | 56.71 a | 12.03 a |
| 10 | 58.18 b | 13.06 b |
| 20 | 59.69 c | 14.37 c |
| LSD (0.05) | 1.467 | 0.571 |
| NPS/urea rate kg ha-1 |  |  |
| 0/0 | 50.87 a | 10.54 a |
| 50/50 | 57.00 b | 12.18 b |
| 100/100 | 60.13 c | 14.31 c |
| 150/150 | 64.78 d | 15.58 d |
| LSD (0.05) | 1.693 | 0.659 |
| CV (%) | 3.0 | 5.1 |

**Leaf Length (cm)**

Leaf length in onion was significantly (P < 0.05) influenced by the main effects of NPS/urea and farmyard manure (FYM) application rates, as well as by their interaction. The longest leaves, measuring 55.13 cm, were recorded in the treatment that combined 150/150 kg ha⁻¹ of NPS/urea with 20 t ha⁻¹ of FYM, while the shortest leaves, at 29.73 cm, were observed in the untreated control. This increase in leaf length is likely due to the stimulating effect of nitrogen on vegetative growth, as it plays a vital role in carbohydrate production and utilization through photosynthesis and various metabolic processes. These findings align with those of Kokobe et al. (2013), who reported significant improvements in vegetative growth traits of onion, including leaf length and number, with increasing NPS/urea application rates up to 150 kg N ha⁻¹.

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Table 3. Leaf length (cm) of onion as influenced by the interaction of NPS/urea and FMY rates

|  |
| --- |
| NPS/urea rate kg ha-1 |
| Farmyard manure t/ha | 0/0 | 50/50 | 100/100 | 150/150 |
| 0 | 29.73 a | 35.0bc | 39.87de | 43.73fg |
| 10 | 32.73b | 37.67cd | 44.53g | 50.93h |
| 20 | 34.47b | 41.67ef | 48.47h | 55.13i |
| LSD (0.05) |  | 2.632 |  |  |
| CV (%) |  | 5.1 |  |  |

## 3.2. Effect of NPS/urea and farmyard manure application on Yield and yield components of onion

## Bulb Diameter (cm)

## Bulb diameter of onion was significantly (P < 0.01) influenced by the main effects of NPS/urea and FYM application rates, although their interaction effect was not significant. The largest bulb diameter (7.289 cm) was observed with the application of 150/150 kg ha⁻¹ NPS/urea, while the smallest (5.744 cm) was recorded under the control treatment with no fertilizer applied. This finding aligns with those of Gererufael et al. (2020) and Yohannes et al. (2017), who reported increased bulb diameter with the application of both organic and inorganic fertilizers. The increase in bulb diameter can be attributed to the improved nitrogen availability provided by both types of fertilizers, which likely enhanced chlorophyll and amino acid synthesis. This, in turn, may have promoted the translocation of photosynthates from the leaves to the bulbs, leading to larger bulb size (Shedeed et al., 2014; Tana and Wolde, 2015).

## Neck Diameter (cm)

## The analysis of variance revealed that the main effects of NPS/urea and FYM application rates significantly (P < 0.01) influenced onion neck diameter, although their interaction effect was not significant. The maximum neck diameter (1.678 cm) was recorded with the application of 150/150 kg ha⁻¹ NPS/urea, while the minimum (1.289 cm) was observed in the control treatment with no fertilizer. Similarly, Yohannes et al. (2017) highlighted that neck diameter is a key trait significantly affected by the combined use of organic and inorganic fertilizers.

## Average Bulb Weight (g)

## The average bulb weight of onion was significantly (P < 0.01) influenced by the main effects of NPS/urea and FYM application rates, though their interaction effect was not significant (Table 4). The highest bulb weight (135.3 g) was recorded under the application of 150/150 kg ha⁻¹ NPS/urea, while the lowest (99.2 g) was observed in the control plot. This finding aligns with the results of Kokobe et al. (2013), who noted a significant impact of N and FYM on bulb weight. Furthermore, Jayathilake et al. (2002) reported that “combining organic and inorganic fertilizers can increase bulb weight by approximately 8.1% to 12.2% compared to unfertilized control. The increase in bulb weight may be attributed to improved vegetative growth such as plant height, leaf number, and leaf length, which are positively influenced by higher nitrogen levels” (Shedeed et al. 2014).

## Table 4. Effect of NPS/urea and farmyard manure application on Yield and yield components of onion

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment | Bulb diameter (cm) | Neck diameter (cm) | Average bulb weight (g) |
| FYM t ha-1 |  |  |  |
| 0 | 6.100 a | 1.433 a | 104.2 a |
| 10 | 6.258a | 1.475 a | 120.5 b |
| 20 | 6.942 b | 1.583 b | 129.8 c |
| LSD (0.05) | 0.1708 | 0.04641 | 3.439 |
| NPS/urea rate kg ha-1 |
| 0/0 | 5.744 a | 1.289 a | 99.2 a |
| 50/50 | 6.056 b | 1.422 b | 112.6 b |
| 100/100 | 6.644 c | 1.600 c | 125.6 c |
| 150/150 | 7.289d | 1.678 d | 135.3 d |
| LSD (0.05) | 0.1972 | 0.05359 | 3.971 |
| CV (%) | 3.1 | 3.7 | 3.4 |

## Marketable Bulb Yield (t/ha)

## The marketable yield of onion bulbs was significantly (P < 0.05) influenced by the individual application of NPS/urea and FYM, whereas their interaction had no significant effect. The highest marketable yield (17.21 t ha⁻¹) was recorded with the application of 150/150 kg ha⁻¹ NPS/urea, while the lowest yield (9.78 t ha⁻¹) was observed in the control treatment. This result supports the findings of Alemu et al. (2022), who noted that increased application of both organic and inorganic fertilizers leads to enhanced marketable bulb yield in onions.

## Unmarketable bulb yield (t/ha)

## The unmarketable bulb yield was significantly affected by the main effect of NPS/urea fertilizer (P < 0.01), while the main effect of composted FYM also showed a significant impact (P < 0.05); however, their interaction had no significant effect. The highest unmarketable bulb yield (0.5264 t/ha) was recorded in plots without any NPS/urea fertilizer application, whereas the lowest yield (0.1381 t/ha) was obtained from plots treated with 150/150 kg/ha of NPS/urea fertilizer. Plots that did not receive NPS/urea fertilizers produced a greater amount of unmarketable bulbs compared to those receiving higher fertilizer doses.

## Total Bulb Yield (t/ha)

## Total bulb yield of onion was significantly influenced (P < 0.01) by the main effects of the treatments, though their interaction did not show a significant effect (Table 6). The highest total bulb yield (17.34 t/ha) was obtained from the combined application of 150/150 kg/ha of NPS and urea fertilizers, whereas the lowest yield (10.34 t/ha) was recorded in the control plots without fertilizer application. Similar findings were reported by Bashir and Qureshi (2014), who observed higher onion bulb yields with the application of 180 kg N/ha and 24 t FYM/ha. Likewise, Kokobe et al. (2013) noted a maximum bulb yield of 36.85 t/ha with the combined application of 100 kg N/ha and 45 t FYM/ha.

## The reduced total bulb yield in the untreated control plots could be attributed to a deficiency of essential nutrients typically supplied by NPS and urea fertilizers. This improvement in yield under fertilized treatments is likely due to the role of NPS, urea, and FYM in enhancing plant physiological and metabolic activities, thereby promoting greater dry matter production and accumulation.

Table 5. Effect of NPS/urea and farmyard manure application rates on Yield parameters of onion

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment | MBY (t ha−1) | UMBY (t ha−1) | TBY (t ha−1) |
| FYM t ha-1 |  |  |  |
| 0 | 12.23a | 0.2975 b | 12.52 a |
| 10 | 12.48a | 0.3001 b | 12.78 a |
| 20 | 14.19 b | 0.2060 a | 14.40 b |
| LSD (0.05) | 0.800 | 0.0827 | 0.800 |
| NPS/urea rate kg ha-1 |
| 0/0 | 9.78 a | 0.5264 b | 10.31 a |
| 50/50 | 11.50 b | 0.2194 a | 11.72 b |
| 100/100 | 13.38 c | 0.1875 a | 13.57 c |
| 150/150 | 17.21 d | 0.1381 a | 17.34 d |
| LSD (0.05) | 0.924 | 0.0955 | 0.924 |
| CV (%) | 7.3 | 10.8 | 7.1 |

# **4.Conclusions and Recommendations**

**4.1. Conclusion**

The findings of this study demonstrate that the combined application of inorganic (NPS/urea) and organic (manure) fertilizers significantly enhances the growth, yield, and yield components of onion. In Ethiopia, including the study area, onion productivity remains low due to imbalanced fertilizer use by farmers. To address this, an experiment was conducted during the 2023/2024 main cropping season at the Fafan Agricultural Research Center to evaluate the effects of integrated nutrient management.

The results showed that most phenological, growth, and yield traits were significantly influenced by the main effects of NPS/urea and organic manure. Notably, days to maturity, plant height, number of leaves, leaf length, and neck diameter responded positively to fertilizer application. The highest plant height, leaf number, and leaf length were recorded with the combined application of 150/150 kg/ha NPS/urea and 20 t/ha organic manure.

**4.2. Recommendation**

Based on the results of this study, the adoption of integrated soil fertility management practices is recommended to enhance onion production in the study area. Priority should be given to soil management strategies that improve soil fertility and raise soil pH. The combined application of 150/150 kg/ha of NPS/urea fertilizer with 10–20 tons/ha of organic manure was found to be the most effective approach, offering a potentially sustainable alternative to the exclusive use of inorganic fertilizers. However, to confirm these findings and support wider application, additional research across various locations and cropping seasons is necessary.

## DECLARATIONS

Ethics approval and consent to participate were not applicable to this study. All authors provided full consent to participate in and publish this article. Additionally, the authors declare that they have no competing interests related to this work.

## DATA AVAILABILITY

The datasets generated and/or analyzed during this study are available from the corresponding author upon reasonable request. All data utilized in this research are securely archived and will be made accessible to interested researchers for verification and further analysis, in compliance with institutional and ethical guidelines.

Disclaimer (Artificial intelligence)

Option 1:

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 the writing or editing of this manuscript.

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