# Evaluating the Growth and Yield Response of Sweet Potato [*Ipomoea batatas* (L.) Lam] to Combined Application of Nitrogen and Farmyard Manure Fertilizer

**Biratu Abeshu**
*Department of Horticulture, Faculty of Agriculture, Wallaga University Shambu Campus, Shambu, Ethiopia, Email: biratuabeshu@gmail.com; ORCID: https://orcid.org/0009-0000-6126-2432*

## Abstract

*Sweet potato is the most common and valuable food security crop grown for its edible tubers in Ethiopia as well as in many other countries. Even thought the crop is the most important among the other root and tuber crop, the yield obtained from per hectare is lower due to inappropriate and poor application of fertilizer.Sweet potato requires adequate fertilizer to form good-sized tubers. Therefore, a field experiment was conducted to determine the response of sweet potato to the combined application of nitrogen fertilizer and farmyard manure in the study area. The experiment included three levels of farmyard manure (0, 5, and 10 t ha$^{-1}$) and four levels of nitrogen fertilizer (0, 40, 70, and 100 kg N ha$^{-1}$). The factorial combination of the treatments was laid out in a randomized complete block design with three replications. Different growth and yield parameters were collected,and analysis of variance was undertaken using SAS (version 9.3). Treatment means were separated using the least significant difference at 5% level of probability. The results showed that the interaction effect between nitrogen fertilizer and farmyard manure significantly (P <0.05) affected yield and yield components of sweet potato. The highest vine length (160.23 cm), shoot fresh weight (1009.6 g hill$^{-1}$), shoot dry weight (141.35 g hill$^{-1}$), days of bud sprouting (13.27), days of physiological maturity (147.8), number of branches per plant (7.30), harvest index (0.36%) tuber diameter (22.5 cm), total tuber yield (22.45 t/ha), marketable tuber yield (21.85 t/ha), and unmarketable tuber yield (3.25 t/ha) were recorded in plots that received 10 t ha$^{-1}$ farmyard manure and 100 kg/ha nitrogen fertilizer. The findings showed that the application of inorganic nitrogen fertilizer along with farmyard manure might improve the growth, production, and yield components of sweet potato. However, as the experiment was conducted for only one season at one location, it needs to be undertaken at different locations and times to reach a conclusive result.*

**Keywords** : Awassa, food security, harvest index, Nejo, tuber crop, vine

## Introduction

Sweet potato (*Ipomoea batatas* L.) Lam) is an important tuber crop that has the innate potential of generating more edible energy than most major food crops. It is also ideal for production on marginal soils and plays a significant role as a food security crop (Motsa *et al*,.2015). Van Jaarsveld *et al. (2005)* indicated that in many developing countries, sweet potato represents a major part of the diet and is regarded as a secondary staple item. Sweet potatoes are useful for human consumption, animal feeds and industrial uses in all parts of the world. According to Esan *et al.,* (2021) and Boru *et al*., (2017) lack of recommended fertilizers is the major bottleneck that limits sweet potatoes from attaining their genetic potential.

Sweet potatoes respond well to farmyard manures and intensive cropping systems may maintain soil and soil fertility for increased crop yields and better crop quality *(*Abdissa *et al*., 2011). Because of the known and anticipated benefits, the world is currently shifting to organic crop farming. Sweet potato growth characteristics benefited from the application of farmyard manure, NPK, and other compound fertilizers, which is related to their roles in improving soil structure, nutrients, and water retention. Nitrogen application led to longer vines, more leaves, and more branches, which in turn resulted in heavier above-ground dry biomass (Kassim *et al*., 2016) The main reasons for the low yields of sweet potatoes are the poor agronomic practices, such as a lack of knowledge about the recommended rates of fertilizer, and the low soil fertility that resulted in low sweet potato yield since the farmers do not use inorganic and organic fertilizer (Boru *et al.,2017).* As a result, the goal of the study was to determine how the sweet potato responded to the application of nitrogen and farmyard manure fertilizer together in the study areas.

# Materials and Methods

## Description of the study sites

The study was conducted at Nejo West Wollega Zone of the Oromia Regional State, Ethiopia in the farmers' training center (FTC) on July 07/2021 -December 07 2021.The district is located at 9o20 N – 9º 40'' N latitude and 35º 20''E - 35º 40''E longitude. The site is located 500 km west of Addis Ababa 75 km west of Gimbi. It has an altitude ranging from 1600 to 1900 meters above sea level. The region receives between 1000 to 1600 mm of rainfall per year and it has the minimum and maximum temperature of 12 and 26 °C .

**Description of the Experimental Materials:** Five hundred kilograms of vine cuttings of Awassa -83 variety were taken from Hawassa Agricultural Research Center. The variety was chosen because it could adapt to the research region, had a high yield potential, and disease resistances.

**Table 1: Specific properties of the variety used in study**

| Variety | Released year | Maturity period | Adaptation zone | Yield/ha |
|---|---|---|---|---|
| Awassa-83 | 1998 | 151-160 | Mid | 36.61 |

Source: Yitages,2017)

**Treatments and Experimental Design:** The experiment comprised of the three levels (0, 5, and 10 tons $ha^{-1}$) of farmyard manure and four rates of N fertilizer (0, 40, 70 and 100 kg $ha^{-1}$). Factorial combinations of the treatments were laid out in a randomized complete block design (RCBD) with three replications.

**Experimental Procedure:** The field was ploughed with oxen and the plots were manually leveled. Well dried cow dung was collected from Nejo animal farm found in the vocational training school. It plied and stored for three months for proper decomposition before application to the field. Farmyard manure was spread on the designated plots one month prior to planting to ensure decomposition. A full dose of inorganic nitrogen (N) fertilizer was applied as side banding during planting. The size of the plots was 3.6m*3.6m. There were six rows on each plot which accommodates twelve plants. The distance between blocks and plots were 1.5m and 1m respectively. The number of vines required for each plot were 72 and 2592 number of vines were required for total plots. Urea and FYM were the two source of nitrogen fertilizer. In each bed, rows of vines were planted on 07 July 2021 with care. Additionally, other agronomic measures weeding, earthing-up, hoeing were maintained uniformly for all treatments later on.

**Data Collection and analysis:** Data on growth, yield, and yield components were collected. by using different instruments. Analysis of variance (ANOVA) was undertaken using SAS version 9.3. Whenever the ANOVA, List Significance Difference (LSD) at the 5% level of confidence was used to separate the treatment means.

# Results and Discussion

**Bud sprouting days.** The results of the current study demonstrated that the interaction between nitrogen and farmyard manure had a highly significant $p \leq 0.01$) impact on the days to 50% -bud sprouting. The combination of 10 t ha$^{-1}$ farmyard manure and 100 kg nitrogen fertilizer gave the quickest days to 50% bud sprouting (6.34 days), which was 52.22% faster than the control. The value (6.88 days) obtained from the combined application of 5 t ha$^{-1}$ FYM and 100 kg ha$^{-1}$ of nitrogen fertilizer was applied next. The control took the longest time to 50% bud sprouting (13.27 days) (Table 2). The hastening effects of the highest rates of FYM and N fertilizer could be attributed to the better water-holding capacity around the root zone of the cutting materials, which encouraged the emergence of roots and prompted the buds to sprout quickly, , as well as its nutrient makeup. Teshome *et al*. (2012), pointed out that the major effects of P and farmyard manure and their combination significantly affected the day to 50% bud sprouting of sweet potato. Boru *et al.* (2017) observed that the application of compost to the sweet potato farm affected the number of days to budding.

**Days to physiological maturity:** The analysis of variance showed that the combined effects of N and FYM had highly significant ($p \leq 0.01$) effect on days of physiological maturity. The combined application of 10 t ha$^{-1}$ FYM and 100 kg ha$^{-1}$ nitrogen fertilizer significantly delayed maturity (147.8 days), which was 28.8 percent days later than the control. The combined application of 5 t ha$^{-1}$ FYM and 100 kg ha$^{-1}$ of N fertilizer led the sweet potato to maturity in 142.3 days. On the other hand, the crop that received no fertilizer reached physiological maturity in 119 days (Table 2). The findings indicated that sweet potato maturity was delayed by increasing the rate of FYM, which might be due to its accelerating effects on vegetative growth. The results were consistent with those of Zelalem *et al.* *(*2009), who found that application of N and P fertilizers prolonged the time to flowering and physiological maturity of potatoes from 90 to 120 days.

**Number of primary branches per plant***:* The results of the current study showed that the interaction between nitrogen and farmyard manure fertilizer had a highly significant ($P < 0.01$) influence on the number of primary branches per plant. The combination of 10 t $ha^{1}$ farmyard manure and 100 kg nitrogen fertilizer produced the highest number of primary branches per plant (7.30), which was 70.56% higher than the control (10 t $ha^{-1}$ FYM and 0 kg Nitrogen). The value (7.06), obtained by combining the application of 100 kg of nitrogen fertilizer and 5 t $ha^{-1}$ FYM is followed. The control had the fewest primary branches per plant (4.28) (Table 1). The increase in vine length caused by the presence of nitrogen fertilization may be responsible for the increase in the number of branches as affected by farmyard manure and nitrogen fertilizer supply. Stronger roots enable a plant to absorb water from deeper layers, and farmyard manure and inorganic fertilizers combine well to improve crop root penetration and establishment *(*Hati *et al*., 2007).

**Vine length:** The interaction of nitrogen and farmyard manure fertilizer had a highly significant ($P < 0.01$) influence on vine length, according to the analysis of variance. The combination of 10 t $ha^{-1}$ farmyard manure and 100 kg nitrogen fertilizer produced the longest vines (160.23 cm), which was 42.85% longer than the control (0 t $ha^{-1}$ FYM and 0 kg Nitrogen). The value (153.43 cm) resulting from the combined application of 5t $ha^{-1}$ FYM and 100 kg $ha^{-1}$ of nitrogen fertilizer was applied next. The control had the shortest number of days to physiological maturity (112.17 cm) (Table 2). The vine length of the crop also increases as the rate of application of both organic and inorganic fertilizers was increased. This could be a result of those fertilizers having sufficient nutrients. Application of organic manure would have assisted in enhancing the metabolic activities in the plant system through the supply of such crucial micro-nutrients in the early growth phase, which in turn must have encouraged the overall growth of the vines per plant (Sarker e*t al*., 2002). Boru *et al*. (2017), claims that with applied P up to a rate of 46 kg $ha^{-1}$ $P_2O_5$, the Awassa83 sweet potato vine length increased. According to Teshome *et al*. (2012), the study verified the identical outcome that sweet potato benefited little from Potassium fertilizer

**Shoot fresh weight:** According to the analysis of variance, nitrogen fertilizer and farmyard manure had a significant ($p < 0.001$) main effect on the sweet potato shoot's fresh weight. The sweet potato shoot fresh weight was, however, significantly ($p< 0.05$) impacted by the interaction effects of the two fertilizers (Table 1). Due to the combined application of 100 kg of nitrogen fertilizer per hectare and 10 t per hectare of farmyard manure fertilizer, the highest value (1009.6 g $hill^{-1}$) of shoot fresh weight was recorded. While, the smallest shoot fresh weight (109.8 g $hill^{-1}$ was recorded from control (Table 2). This demonstrated that higher levels of farmyard manure rate application have a significant impact on shoot fresh weight. This might be a result of the farmyard manure's nutrient makeup.

**Shoot dry weight*:*** The interaction of nitrogen and farmyard manure fertilizer had a highly significant ($p< 0.01$) influence on the sweet potato shoot dry weight, according to the analysis of variance. The combination of 10 t $ha^{-1}$ farmyard manure and 100 kg nitrogen fertilizer produced the maximum shoot dry weight of sweet potatoes (141.35 g $hill^{1}$) and was 129.50% higher than the control (10 t $ha^{-1}$ FYM and

0 kg Nitrogen). The value (139) obtained from the combined application of 5t $ha^{1}$FYM and 100 kg $ha^{-1}$ of nitrogen fertilizer was applied after that. The control had the shortest days to physiological maturity (61.6ghill$^{-1}$) (Table 1). Furthermore, Saluzzo *et al*. (1999), reported more photochemical active radiation interception, higher dry matter accumulation, and partitioning to the root section could be the causes of N's beneficial impacts on fresh and dry root weight gain.

Table 2: Growth and Phonological parameters of sweet potatoes as affected by farmyard manure and nitrogen fertilizer during 2020–2021.

| **Treatments** FYM (t ha-1) | N (kg $ha^{-1}$) | Vine Length | Shoot fresh weight | Shoot dry weight | Days of Bud Sprouting | DPM | Number buds Per plant |
|---|---|---|---|---|---|---|---|
| | 0 | $112.17^{i}$ | $109.8^{e}$ | $61.6^{g}$ | $13.27^{a}$ | $119^{g}$ | $4.28^{i}$ |
| | 40 | $135.05^{f}$ | $625^{efg}$ | $121.0^{cde}$ | $12.00^{b}$ | $126.3^{ef}$ | $5.56^{g}$ |
| **0** | 70 | $144.44^{e}$ | $755.0^{cd}$ | $128.8^{abc}$ | $9.6^{cd}$ | $133.8^{c}$ | $6.28^{de}$ |
| | 100 | $153.33^{bc}$ | $758.3^{cd}$ | $114.8^{ab}$ | $7.58^{ef}$ | $140.3^{bc}$ | $6.73^{c}$ |
| **5** | 0 | $118.55^{h}$ | $609^{fg}$ | $113.6^{ed}$ | $12.47^{b}$ | $127^{f}$ | $5.04^{h}$ |
| | 40 | $138.38^{f}$ | $616.3^{fg}$ | $119.5^{cde}$ | $10.18^{c}$ | $130.6^{de}$ | $5.68^{f}$ |
| | 70 | $148.50^{de}$ | $710.3^{cdef}$ | $128.2^{bcd}$ | $9.26^{d}$ | 134.5c | $6.48^{cd}$ |
| | 100 | $153.43^{b}$ | $870^{b}$ | 139a | 6.88fg | 142.3b | $7.06^{b}$ |
| **10** | 0 | $121.3^{g}$ | $655.2^{defg}$ | $111.2^{e}$ | 13.17b | 129.1def | $5.36^{g}$ |
| | 40 | $132.12^{f}$ | $718^{cde}$ | $127^{bcd}$ | 11.01cd | 132.3d | $5.98^{ef}$ |
| | 70 | $151.23^{cd}$ | $780.0^{bc}$ | $135.3^{ab}$ | 8.75e | 135.8c | $6.52^{c}$ |
| | 100 | $160.23^{a}$ | $1009.6^{a}$ | $141.35^{a}$ | 6.34g | 147.8a | $7.30^{a}$ |
| LSD (0.05) | | **6.03** | **8.2** | **10.3** | **0.45** | **2.45** | **1.26** |
| CV % | | **4.27** | **5.87.** | **4.34** | **5.23** | **2.33** | **3.34** |

Keys: means sharing common letter(s) are not significantly different at 5% level of Significance FYM farmyard manure, N=Nitrogen, CV =Coefficient of Variation, LSD= Least Significance Difference

**Tuber diameter:** The interaction of nitrogen and farmyard manure fertilizer on the sweet potato storage root diameter was very significant ($P<0.01$) according to the analysis of variance. The combination of 10 t $ha^{-1}$ farmyard manure and 100 kg nitrogen fertilizer was found to produce sweet potatoes with the largest store roots (22.5 cm), which was 44.23% larger than the control (10 t $ha^{-1}$ FYM and 0 kg Nitrogen). The value (21.8 cm) achieved from the combined application of 10t $ha^{-1}$FYM and 70 kg $ha^{-1}$ of nitrogen fertilizer came next. The control plant required the fewest days to reach physiological maturity (15.6cm) (Table 2). This might be a result of FYM increasing the soil's fertility by allowing nutrients to be absorbed by sweet potatoes and enhancing vegetative development and assimilation partitioning in storage roots yield. According to Esan *et al*. (2021), significant variations between the control and treatment plots were seen in the number of tubers affected by organic and inorganic fertilizer and increased amounts of fertilizers, whether organic or artificial, led to more tubers being produced. Similarly, to this, Paderes and Bañoc. (2022), reported that yield and yield components of sweet potatoes were significantly influenced by the combined application of PWC and varying rates of inorganic fertilizers.

| Treatments FYM ( t $ha^{-1}$) | N (kg $ha^{-1}$) | Vine Length | Shoot fresh weight | Shoot dry weight | Days of Bud Sprouting | DPM | Number buds Per plant |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 112.17$^{i}$ | 109.8$^{e}$ 625$^{efg}$ | 61.6$^{g}$ | 13.27$^{a}$ | 119$^{g}$ | 4.28$^{i}$ |
| | 40 | 135.05$^{f}$ | 755.0$^{cd}$ | 121.0$^{cde}$ | 12.00$^{b}$ | 126.3$^{ef}$ | 5.56$^{g}$ |
| | 70 | 144.44$^{e}$ | 758.3$^{cd}$ | 128.8$^{abc}$ | 9.6$^{cd}$ | 133.8$^{c}$ | 6.28$^{de}$ |
| | 100 | 153.33$^{bc}$ | | 114.8$^{ab}$ | 7.58$^{ef}$ | 140.3$^{bc}$ | 6.73$^{c}$ |
| 5 | 0 | 118.55$^{h}$ | 609$^{fg}$ | 113.6$^{ed}$ | 12.47$^{b}$ | 127$^{f}$ | 5.04$^{h}$ |
| | 40 | 138.38$^{f}$ | 616.3$^{fg}$ | 119.5$^{cde}$ | 10.18$^{c}$ | 130.6$^{de}$ | 5.68$^{f}$ |
| | 70 | 148.50$^{de}$ | 710.3$^{cdef}$ | 128.2$^{bcd}$ | 9.26$^{d}$ | 134.5$^{c}$ | 6.48$^{cd}$ |
| | 100 | 153.43$^{b}$ | 870 $^{b}$ | 139a | 6.88$^{fg}$ | 142.3$^{b}$ | 7.06$^{b}$ |
| 10 | 0 | 121.3$^{g}$ | 655.2$^{defg}$ | 111.2$^{e}$ | 13.17$^{b}$ | 129.1$^{def}$ | 5.36$^{g}$ |
| | 40 | 132.12$^{f}$ | 718$^{cde}$ | 127$^{bcd}$ | 11.01$^{cd}$ | 132.3$^{d}$ | 5.98$^{ef}$ |
| | 70 | 151.23$^{cd}$ | 780.0$^{bc}$ | 135.3$^{ab}$ | 8.75$^{e}$ | 135.8$^{c}$ | 6.52$^{c}$ |
| | 100 | 160.23$^{a}$ | 1009.6$^{a}$ | 141.35$^{a}$ | 6.34$^{g}$ | 147.8$^{a}$ | 7.30$^{a}$ |
| LSD (0.05) | | **6.03** | **8.2** | **10.3** | **0.45** | **2.45** | **1.26** |
| CV % | | **4.27** | **5.87.** | **4.34** | **5.23** | **2.33** | **3.34** |


| Treatments FYM ( t $ha^{-1}$) | N (kg $ha^{-1}$) | Vine Length | Shoot fresh weight | Shoot dry weight | Days of Bud Sprouting | DPM | Number buds Per plant |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 112.17$^{i}$ | 109.8$^{e}$ 625$^{efg}$ | 61.6$^{g}$ | 13.27$^{a}$ | 119$^{g}$ | 4.28$^{i}$ |
| | 40 | 135.05$^{f}$ | 755.0$^{cd}$ | 121.0$^{cde}$ | 12.00$^{b}$ | 126.3$^{ef}$ | 5.56$^{g}$ |
| | 70 | 144.44$^{e}$ | 758.3$^{cd}$ | 128.8$^{abc}$ | 9.6$^{cd}$ | 133.8$^{c}$ | 6.28$^{de}$ |
| | 100 | 153.33$^{bc}$ | | 114.8$^{ab}$ | 7.58$^{ef}$ | 140.3$^{bc}$ | 6.73$^{c}$ |
| 5 | 0 | 118.55$^{h}$ | 609$^{fg}$ | 113.6$^{ed}$ | 12.47$^{b}$ | 127$^{f}$ | 5.04$^{h}$ |
| | 40 | 138.38$^{f}$ | 616.3$^{fg}$ | 119.5$^{cde}$ | 10.18$^{c}$ | 130.6$^{de}$ | 5.68$^{f}$ |
| | 70 | 148.50$^{de}$ | 710.3$^{cdef}$ | 128.2$^{bcd}$ | 9.26$^{d}$ | 134.5$^{c}$ | 6.48$^{cd}$ |
| | 100 | 153.43$^{b}$ | 870 $^{b}$ | 139a | 6.88$^{fg}$ | 142.3$^{b}$ | 7.06$^{b}$ |
| 10 | 0 | 121.3$^{g}$ | 655.2$^{defg}$ | 111.2$^{e}$ | 13.17$^{b}$ | 129.1$^{def}$ | 5.36$^{g}$ |
| | 40 | 132.12$^{f}$ | 718$^{cde}$ | 127$^{bcd}$ | 11.01$^{cd}$ | 132.3$^{d}$ | 5.98$^{ef}$ |
| | 70 | 151.23$^{cd}$ | 780.0$^{bc}$ | 135.3$^{ab}$ | 8.75$^{e}$ | 135.8$^{c}$ | 6.52$^{c}$ |
| | 100 | 160.23$^{a}$ | 1009.6$^{a}$ | 141.35$^{a}$ | 6.34$^{g}$ | 147.8$^{a}$ | 7.30$^{a}$ |
| LSD (0.05) | | **6.03** | **8.2** | **10.3** | **0.45** | **2.45** | **1.26** |
| CV % | | **4.27** | **5.87.** | **4.34** | **5.23** | **2.33** | **3.34** |


**Biomass yield:** The interaction of nitrogen and farmyard manure fertilizer had a highly significant ($P < 0.01$) impact on biomass production, according to the analysis of variance. The combination of 10 t $ha^{-1}$ farmyard manure and 100 kg nitrogen fertilizer produced the maximum sweet potato biomass production (1009.2 t/ha), which was 44.23% greater than the control (10 t $ha^{-1}$ FYM and 0 kg Nitrogen). The figure (928 t/ha) achieved with the combined application of 10 t/ha FYM and 70 kg/ha nitrogen fertilizer came next. The control produced the lowest biomass output (579.7 t/ha) (Table 2). The fact that organic materials like farmyard manure enable the right soil structure for the crop may be the cause of this significant difference in results. The results, which were in agreement with those of Widaryanto and Saitama. (2017), showed that sweet potato plants' dry weight partition decreased in the upper soil zone (vegetative) and increased in the root zone and tubers, leading to high tuber yields. In contrast, when vegetative growth predominates, leaves and stems grow excessively and lack tuber formation because there aren't enough carbohydrates left for tuber formation. According to Teshome *et al*. (2012), the maximum level of farmyard manure had an impact on the shoot fresh weight of sweet potatoes.

**Harvest Index:** The results of the current investigation showed that the interaction between nitrogen and farmyard manure fertilizer had a highly significant ($P < 0.01$) impact on the harvest index. The combination application of 10 t $ha^{-1}$ farmyard manure and 100 kg nitrogen fertilizer, which was 70.56% more than the control, resulted in the highest harvest index value of (0.36). The ta/ha (7.06), produced by combining the application of 100 kg of nitrogen fertilizer and 5 t $ha^{-1}$ FYM, came next. The control provided the harvest index's lowest value (0.28%) (Table 2). The harvest index was inversely correlated with marketable and total fresh storage weight per plant as well as marketable and total fresh storage root output in ton $ha^{-1}$. Additionally, it was the outcome of storage root length, total storage root count, and marketable storage root number. It had an inverse relationship with the weight of above-ground fresh biomass. In agreement with this, Boru *et al*. (2017), discovered that the application of FYM led to a significantly affect index of sweet potato. A significant decline in the fresh weight harvest index was seen as the combined N and P levels rose over 45 N kg $ha^{-1}$ and P levels rose from 25 to 75 P kg $ha^{1.}$ He also stated that the largest fresh weight base harvest index was recorded with N levels increasing from 0 to 45N kg $ha^{-1}$ and P levels increasing from 0 to 23Pkgha$^{-1}$.

**Marketable tuber number:** The results of the current study showed that the interaction between nitrogen and farmyard waste fertilizer had a highly significant ($P< 0.01$) impact on the number of marketable tuber roots. The application of 10 t $ha^{-1}$ farmyard manure and 100 kg of nitrogen fertilizer resulted in the maximum marketable tuber root number value of (3.2 t/ha), which was 291% greater than the control (0 t $ha^{1}$ FYM and 0 kg Nitrogen). The value (3.05 t/ha) obtained from the combined application of 5t $ha^{1}$ FYM and 100 kg $ha^{-1}$ of nitrogen fertilizer was applied next. The control provided the lowest result for the number of marketable tuber roots (0.83 t/ha) (Table 3). The marketable tuber number increased as the rate of farmyard manure and nitrogen fertilizer application increased which might be due presence of mineral nutrients in those fertilizers. According Boru et *al*. (2017), the main effects of FYM, P and the interaction of the two factors were significant ($P<0.05$) on the marketable yield tuber number of sweet potatoes

Table 3: Yield and yield components of sweet potatoes were affected by farmyard manure and nitrogen fertilizer during 2020–2021

| **Treatments** | | **Yield parameter** | | |
|---|---|---|---|---|
| Farm yard manure t ha$^{-1}$ | **Nitrogen** Kgha$^{-1}$ | Total Storage Tuber Diameter | Harvest Index | Biomass Yield |
| 0 | 0 | 15.6$^{e}$ | 0.28$^{f}$ | 579.7$^{f}$ |
| | 40 | 16.3$^{d}$ | 0.31$^{e}$ | 741.9$^{d}$ |
| | 70 | 21.0$^{bc}$ | 0.31$^{cde}$ | 628.8$^{f}$ |
| | 100 | 20$^{cd}$ | 0.32$^{bcda}$ | 671.0$^{f}$ |
| 5 | 0 | 18.2$^{d}$ | 0.30$^{e}$ | 592.0$^{f}$ |
| | 40 | 19.7$^{bc}$ | 0.31$^{de}$ | 741.8$^{d}$ |
| | 70 | 18.2$^{cd}$ | 0.32$^{cde}$ | 791$^{c}$ |
| | 100 | 21.4$^{ab}$ | 0.33$^{bc}$ | 776.9$^{c}$ |
| | 0 | 20.2$^{abc}$ | 0.31$^{de}$ | 703.3$^{de}$ |
| 10 | 40 | 18.8$^{bcd}$ | 0.33$^{de}$ | 708.3$^{de}$ |
| | 70 | 21.8$^{abc}$ | 0.34$^{ab}$ | 928$^{b}$ |
| | 100 | 22.5$^{a}$ | 0.36$^{a}$ | 1009.2$^{a}$ |
| **LSD(0.05)** | | **3.2** | **0.073** | **34.6** |
| **CV %** | | **7.8** | **5.56** | **7.65** |

*Key means sharing a common letter(s) are not significantly different at the 5% level of significance, CV =Coefficient of Variations, LSD= Least Significance Difference*

**Unmarketable tuber number:** According to the analysis of variance, nitrogen fertilizer and farmyard manure had a substantial ($p<0.001$) impact on the number of sweet potato tubers that were unmarketable. The number of unmarketable sweet potato tuber roots was, however, significantly ($p<0.05$) impacted by the interaction effects of the two fertilizers. The lowest yield (0.02) was obtained at 0 t FYM ha$^{-1}$ + 0-kilogram nitrogen ha$^{-1}$ fertilizer, while the highest tuber root number per plant (0.38) was recorded at 10 t farmyard manure ha$^{-1}$ + 100 kg nitrogen fertilizer ha$^{-1}$ (Table 3). The outcome showed that as nitrogen fertilizer application rates and FYM application rates increased, sweet potato yield increased. This might be as a result of FYM application, which enriches the soil and improves the soil's capacity to absorb macro- and micro-nutrients crucial to increase tuber yield. Sidhu *et al*. (2007), showed that adding 50 t FYM ha$^{-1}$ of potato to the crop increased yield (both marketable and unmarketable tubers) by 29% compared to the FYM untreated control. Beetles and other insect pests caused an increase in unmarketable tubers, which should be controlled by an integrated pest management system since they rendered the tubers shapeless and unacceptably unmarketable.

**Total Tuber Yield:** According to the analysis of variance, farmyard manure and inorganic N fertilizer had a significant ($p<0.001$) impact on the total sweet potato tuber production. The sweet potato marketable root yield was, however, significantly ($p< 0.05$) impacted by the interaction effects of the two fertilizers. 10 t FYM ha$^{-1}$ + 100 kg N ha$^{-1}$ produced the highest tuber production per hectare (22.45 t ha$^{-1}$), while 0 t FYM ha$^{-1}$ + 0 kg N ha$^{-1}$ produced the lowest yield (7.05 t ha$^{-1}$)

(Table 3). The low fertility of the experimental site, which led to the lowest yield of the control, may be to blame for the significant yield gap between the treatments. According to Boru *et al*. (2017), the application of inorganic phosphorus may have complemented the applied FYM's low phosphorus content and raised the amount of P that was readily available in the soil. Israel *et al*.(2015), the total tuber yield of potatoes was highly significantly ($P<0.01$) affected by the application of cattle manure and inorganic NP and increasing the application rates of cattle manure and inorganic NP from 0 to 7.5 t/ $ha^{-1}$ increased the total tuber yield from 25.78 to 40.20 t/ ha and 22.63- 34.22 t/ ha

**Marketable tuber yield:** The analysis of variance revealed that the main effects of nitrogen fertilizer and farmyard manure were highly significant ($p<0.01$). Sweet potatoes, however, produce a significant amount of marketable root ($p<0.05$). The highest marketable root yield (21.85 $tha^{-1}$) was obtained by combining 10 t FYM $ha^{-1}$ with 100 kg nitrogen $kg^{-1}$, whereas the lowest yield (7.65 $tha^{1}$) was created by combining 0 t $ha^{-1}$ FYM with 0 kg nitrogen $kg^{-1}$ (Table 3). Because organic manure and inorganic fertilizer work well together and complement one another, they may produce the best yield when applied together. This is true for both nitrogen fertilizers and farmyard manure at the highest rates. Given that storage roots are the primary edible organ of sweet potatoes, they are one of the key yield determining factors in root and tuber crops

**Unmarketable tuber yield:** According to the analysis of variance, nitrogen fertilizer and farmyard manure had a substantial ($p <0.001$) negative impact on the amount of sweet potato root that was unsuitable for the market. The sweet potato's marketable root yield is also considerably ($p <0.05$) impacted by the interaction effect of the two fertilizers. The control treatment yielded the highest value of unmarketable yield (3.25 t/ha). The application of 10 tons per hectare of farmyard waste and 100 kilograms per hectare of nitrogen fertilizer resulted in the lowest value (0.31 t/ha), which was recorded. The outcome showed that the amount of unmarketable tuber output decreased as the rate of inorganic and organic fertilizer application to the sweet potato farm was increased (Table 3). This might be a result of the FYM application, which improved the soil's capacity to absorb macro- and micro-nutrients crucial for raising tuber yield. As a result of tuber bulking size, the sweet potato produced a disproportionately high production of unmarketable roots yet benefited from FYM overall. Sidhu *et al*. (2007), found that adding 50 t FYM $ha^{-1}$ in potato over FYM untreated control resulted in a 29 % yield increase marketable and unmarketable tubers). Beetles and other insect pests caused an increase in unmarketable tubers, which should be controlled by an integrated pest management system since they rendered the tubers unmarketable and shapeless. Hameda *et al*. (2011), found that applying 15 kg and 45 kg $ha^{-1}$ increased the total (marketable unmarketable) and commercial yield tuber yield of sweet potatoes by 8% and 20%, respectively compared to the results obtained without applying Phosphorus $P_2O_5$.

Table 4: Yield and yield components of sweet potatoes were affected by farmyard manure and nitrogen fertilizer during 2020–2021.

| | **Yield parameter** | | | | | |
|---|---|---|---|---|---|---|
| **FYM (tha$^{-1}$)** | **N ( kg ha$^{-1}$)** | **TTY** | **MTY** | **UMTY** | **MSTN** | **UMSTN** |
| | 0 | $7.05^{g}$ | $7.65^{g}$ | $3.25^{a}$ | $0.83^{g}$ | $0.38^{a}$ |
| | 40 | $12.56^{ef}$ | $11^{ef}$ | $1.85^{bcd}$ | $1.86^{ef}$ | 0.28b$^{cd}$ |
| **0** | 70 | $15.2^{cd}$ | $13.05^{cde}$ | $2.46^{b}$ | $2.12^{cde}$ | $0.33^{b}$ |
| | 100 | $16^{cd}$ | $14.2^{cde}$ | $1.85^{bcd}$ | $2.12^{cde}$ | $0.31^{bcd}$ |
| **5** | 0 | $11^{f}$ | $9^{f}$ | $1.97^{bc}$ | $1.57^{f}$ | $0.25^{bc}$ |
| | 40 | $15.85^{de}$ | $13.89^{de}$ | $1.58^{bcd}$ | $2.1^{de}$ | $0.26^{bcd}$ |
| | 70 | $17.33^{bc}$ | $16.56^{cde}$ | $1.72^{bcd}$ | $2.37^{cd}$ | $0.29^{bcd}$ |
| | 100 | $20.0^{ab}$ | $18.34^{ab}$ | $1.54^{cd}$ | $3.05^{ab}$ | $0.21^{d}$ |
| | 0 | $13.75^{ef}$ | $11.95^{ef}$ | $1.30^{d}$ | $1.75^{ef}$ | $0.21^{cd}$ |
| **10** | 40 | $16.23^{cde}$ | $14.55^{cde}$ | $1.34^{d}$ | $2.12^{cde}$ | 0.21cd |
| | 70 | $21.44^{bc}$ | $18.45^{bc}$ | $1.27^{d}$ | $2.76^{bc}$ | 0.22cd |
| | 100 | $22.45^{a}$ | $21.85^{a}$ | $0.31^{e}$ | $3.2^{a}$ | $0.02^{e}$ |
| | **4.76** | **5.90** | **2.11** | **3.22** | **1.30** | |
| | **6.25** | **7.90** | **13.23** | **8.89** | **9.16** | |

*Key means sharing common letter(s) are not significantly different at a 5% level of significance, FYM = Farmyard manure, N=Nitrogen, TY=Total yield, MY=Marketable yield, UMY= Unmarketable yield, LSD= Least Significance Difference. CV =Coefficient of Variations*

# Conclusion

The current study identified that sweet potatoes strongly respond to fertilizer application. The total tuber yield obtained due to the combined application of 10 t/ha farmyard manure plus 100 kg/ha nitrogen fertilizer exceeded the control by 68.6%. Overall, the results of the present study showed that the growth, production, and yield related characteristics of sweet potatoes were increased were all increased by the applications of nitrogen and farmyard manure fertilizers. As a result, the integrated application of 100 kg ha$^{1}$ N fertilizer and 10 t ha$^{-1}$ farmyard manure enabled the highest total tuber yield. Additionally, farmers in the study area should be encouraged to use an integrated nutrient management system rather than applying only inorganic and organic fertilizers. Doing so improves the soil's physicochemical characteristics and significantly improves sweet potato growth, yield, and yield components.

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