

Review Article

Response of Sweet Potato (*Ipomoea Batatas* L.) Variety to Nitrogen and Farmyard Manure Fertilizer Application in Mulo District, Ethiopia

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Abstract

A field experiment was carried out during the 2020–2021 growing season to examine how the sweet potato responded to various doses of organic and inorganic fertilizer. The treatment included three levels of farmyard waste and four levels of nitrogen fertilizers (0, 40, 70, and 100 kg N ha⁻¹) (0, 5 and 10 FYM t ha⁻¹). The experiment was performed three times and set up using a Randomized Complete Block Design in a factorial layout. Software called SAS (version 9.3) was used to examine the data. The findings showed that the majority of the growth, yield, and yield components were significantly (P 0.01) impacted by the application of N and farmyard manure fertilizers. The highest and lowest vine lengths measured were 160.23 and 112.17 cm, respectively. Other measurements included shoot fresh weight (1009.6 and 109.8 g hill⁻¹), shoot dry weight (141.35 and 61.6 g hill⁻¹), days of bud sprouting (13.27 and 6.34), days of physiological maturity (147.8 and 119), number of branches per plant (7.30 and 4.28), harvest index (0.36 and 0.28%), biomass yield (1009.2 and 579.7), tuberous storage tuber diameter (22.5 and 15.6 cm), total tuber yield (22.45 and 7.05 tha⁻¹), marketable tuber yield (21.85 and 7.65 tha⁻¹), unmarketable tuber yield (3.25 and 0.31 t/ha), marketable storage tuber number (3.2 and 0.83), and unmarketable tuber number (0.38 and 0.02) were obtained from 10t ha⁻¹ farmyard manure plus 100 kg ha⁻¹ N fertilizer. However, the above-mentioned factors were countered by the number of branches per plant, the quantity of unmarketable tubers, and the yield of unmarketable tubers. In conclusion, the findings showed that the application of inorganic nitrogen fertilizer along with farmyard manure might improve the growth, production, and yield components of sweet potatoes. To get more trustworthy data, though, additional research must be done in various environments and at various times of the year while taking fertilizer rates for nitrogen and FYM into account.

Keywords

Farmyard Manure, Fertilizers, Harvest Index, Nitrogen, Sweet Potato

1. Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam) is one of the most significant food crops worldwide. It is cultivated as an annual, starchy staple crop across tropical, subtropical, and temperate

regions [1]. According to FAOSTAT [2], sweet potatoes are grown in more than 115 countries, serving as a crucial secondary staple food in many developing nations. They play a vital

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role in food security and nutrition, particularly in regions where staple grains may be scarce or expensive. Each year, global sweet potato production exceeds 140 million tons, making it a key contributor to the world's food supply. The estimated global average yield of sweet potato storage tubers is approximately 14.8 tons per hectare [3]. This widespread cultivation and high production highlight the crop's importance in addressing food security, providing essential nutrients, and supporting agricultural economies worldwide.

Sweet potatoes are widely cultivated by small-scale farmers in Ethiopia, particularly in the southern, southwestern, and eastern regions, despite their limited access to land, labor, and resources. According to data from the Central Statistical Authority [4], sweet potatoes are grown on approximately 53,499 hectares annually during the primary growing season. In the Oromia region, sweet potatoes are cultivated on about 17,213.16 hectares, ranking second among root and tuber crops after Irish potatoes. With an average annual production of 851,272.93 tons and a yield of 49.455 tons per hectare, Oromia leads the country in root and tuber crop production. Despite this significant production, sweet potato yields in the region remain well below their genetic potential. A major factor limiting productivity is the lack of proper fertilizer recommendations. Poor agronomic practices, including inadequate knowledge of optimal fertilizer application rates, significantly contribute to reduced yields. Farmers often lack access to reliable information on the appropriate types and amounts of fertilizers needed for maximizing sweet potato growth and productivity [5].

A coordinated application of organic manure and inorganic fertilizers has been shown to enhance sweet potato yield. Research indicates that sweet potato growth characteristics respond favorably to farmyard manure, and when combined with inorganic fertilizers, optimal yields can be achieved [6]. Integrated organic and inorganic nutrient management not only sustains soil fertility in intensive cropping systems but also improves both crop yield and quality. Given these benefits, there is a global shift toward organic farming. However, farmers often face challenges such as the bulkiness of organic fertilizers and the delayed benefits despite their long-term advantages. This study evaluates the impact of organic, inorganic, and organo-mineral fertilizers on sweet potato tuber production and quality attributes to determine the most suitable fertilizer type for optimal results [7]. Since organic fertilizer is more beneficial than inorganic fertilizer and does not produce more; sweet potato production will increase with its use. Similar to FYM, the beneficial benefits of compound fertilizers such as Yara Mila Winner, NPK, and farmyard manure on growth characteristics in this study can be attributed to their roles in improving soil structure, nutrients, and water retention. The administration of nitrogen resulted in longer vines, more leaves, and more branches, all of which increased the dry biomass above ground. Using poor agronomic practices, such as not knowing the recommended fertilizer rates, low soil fertility, a lack of improved varieties with high nutritional value, a lack

of planting materials, pests, and the fact that most varieties are white fleshed and lacking in β -carotene, are the main causes of the low sweet potato yields [8]. It seems that sweet potatoes in Ethiopia receive comparatively less fertilizer. Of the 54,017 hectares, only 1073 hectares (1.986%) were fertilized with 239.1 tons of DAP and 156 tons of urea. In the Oromia area, 901.6 tons of fertilizer mixes were applied to just 4562 of the 16,319 hectares of sweet potato cultivation. Consequently, the study's objective was to ascertain how the sweet potato reacted to the combined application of nitrogen and farmyard waste fertilizer in the study area.

2. Materials and Methods

2.1. Description of the Study Site

The experiment was carried out during the 2020–21 off-season cropping in Mulo district, North Shewa, Oromia, Ethiopia. Mulo is situated at an elevation of 2315 meters above sea level and is 31 kilometers north of Addis Ababa. Its coordinates are about 9° 04' 60.0" N latitude and 38° 13' 00.0" E longitude. 6–10 °C is the lowest temperature while 18–23 °C is the highest. With a mean minimum temperature of 8 °C in December and a maximum temperature of 22.9 °C in February and May, the average yearly temperature is 15.36 °C. The experimental site's soil had a pH of 6 and was described as well-drained clay loam with sand (21% sand, loam 21%, and 58% clay).

2.2. Description of the Experimental Materials

In order to conduct the experiment, vine cuttings from ASARC were obtained, and the sweet potato variety Awassa 83, which was introduced by the Awassa Agricultural Research Centre. The variety was chosen due to its disease resistance in the study area, high yield potential, and flexibility.

2.3. Treatment and Experimental Design

Two components were used in the treatment: three levels of farmyard waste rates (0, 5, and 10 tons ha⁻¹) and four levels of N fertilizer application rates (0, 40, 70, and 100 kg ha⁻¹). A total of 36 experimental plots were created by the experiment, which was set up as a randomized complete block design (RCBD) in a factorial layout and reproduced three times. Each plot was given one of the twelve treatment combinations.

2.4. Experimental Procedure

Plots were manually leveled after the trial field was cleared and ploughed by oxen. Depending on the treatment, a complete dose of inorganic nitrogen (N) fertilizer, which is the source of mineral nutrients, was applied as a side banding at planting time. Farmyard manure was spread to the designated plots one month before to planting to assure its break-

down. In July 2020, rows of well-prepared vines were planted in each bed. Subsequently, further agronomic procedures were maintained consistent across all treatments as suggested and implemented for the site.

2.5. Data Collection and Analysis

At harvest, information on growth, yield, and yield components was gathered. Analysis of variance (ANOVA) was used to statistically assess the gathered data, and List Significance Difference (LSD) was used to distinguish the treatment means at a 5% probability level. Each plot's four interior rows aside from the boundary rows had five plants marked. From the sample plants, all yield and yield component data were gathered. 105 days after planting, vegetative data were gathered at the beginning of flowering and when the area was completely covered.

3. Results and Discussion

3.1. Phenological and Growth Parameters

3.1.1. Bud Sprouting Days

The current study demonstrated that the interaction of nitrogen and farmyard waste fertilizer had a highly significant ($p < 0.01$) impact on the day to bud sprouting. The combination of 10 t ha⁻¹ farmyard manure and 100 kg nitrogen fertilizer produced the quickest day to 50% bud sprouting (6.34 days), which was 52.22% quicker than the control (0 t ha⁻¹ FYM and 0 kg nitrogen). The figure (6.88 days) that was attained as a consequence of applying 100 kg ha⁻¹ of nitrogen fertilizer in addition to 5 t ha⁻¹ FYM came next. The control had the shortest time to bud sprouting (13.27 days) (Table 1). The outcome could be attributed to the nutrient composition of the farmyard manure as well as its high water-holding capacity surrounding the cutting materials' root zone, which permits the start of roots and causes the buds to sprout immediately. This result is consistent with the findings of [9], which showed that the day to bud sprouting of sweet potatoes was strongly influenced by the primary effects of P and farmyard manure as well as their interaction..

3.1.2. Days to Physiological Maturity of Sweet Potato

The current study found that the combination of nitrogen and farmyard manure fertilizer had a highly significant ($P < 0.01$) impact on the day to physiological maturity. The combined application of 10 t ha⁻¹ farmyard manure and 100 kg nitrogen fertilizer resulted in the longest days to maturity (147.8 days), which was 24.20% longer than the control (0 t ha⁻¹ FYM and 0 kg Nitrogen). The figure (142.3 days) that was attained as a consequence of applying 100 kg ha⁻¹ of nitrogen fertilizer and 5 t ha⁻¹ FYM together came next. The

control group provided the days to physiological maturity (119 days) (Table 1). The results has shown that the increasing rate of farmyard manure delayed the time of maturity of sweet potato, which may be attributed to that manure plays a significant role in promoting vegetative growth. The finding is in line with the work of [10] who reported that the application of N and P fertilizers delayed flowering and prolonged the day required to attain physiological maturity of potatoes.

3.2. Growth and Yield Parameters

3.2.1. Number of Primary Branches per Plant

The current study found that the interaction between nitrogen and farmyard waste fertilizer had a highly significant ($P < 0.01$) impact on the number of major branches per plant. The combination of 10 t ha⁻¹ farmyard manure and 100 kg nitrogen fertilizer produced the greatest number of primary branches per plant (7.30), which was 70.56 percent more than the control (0 t ha⁻¹ FYM and 0 kg Nitrogen). The figure (7.06) that was attained as a consequence of applying 100 kg ha⁻¹ of nitrogen fertilizer and 5 t ha⁻¹ FYM together came next. The control had the fewest primary branches per plant (4.28; Table 1). The increase in vine length brought on by nitrogen fertilization may be the cause of the growth in branches as influenced by farmyard manure and nitrogen fertilizer availability. The increased availability of water in the plant's root zone under a soil moisture stress scenario, which is quite common in rain-fed farming, may be the cause of the increase in vine length in response to the increased rate of FYM [11].

3.2.2. Vine Length of Sweet Potato

The analysis of variance indicated that the vine length was highly significantly ($P < 0.01$) influenced by the interaction between nitrogen and farmyard manure fertilizers. The highest vine length (160.23 cm) was recorded with the combination of 10 t ha⁻¹ of farmyard manure and 100 kg of nitrogen fertilizer, which was 42.85% higher than the control treatment (0 t ha⁻¹ of farmyard manure and 0 kg of nitrogen). This was followed by a vine length of 153.43 cm from the combined application of 5 t ha⁻¹ of farmyard manure and 100 kg ha⁻¹ of nitrogen fertilizer. The control treatment had the shortest vine length (112.17 cm) (Table 1). As the rates of both organic and inorganic fertilizers increased, the vine length of the crop also increased. This could be attributed to the presence of sufficient nutrients in the applied fertilizers. The application of organic manure likely enhanced the plant's metabolic activities by supplying essential micronutrients during the early growth phase, which, in turn, supported overall vine growth. These findings are consistent with the report by [12], which noted an increase in vine length with phosphorus application up to 46 kg ha⁻¹ of P₂O₅ in Awassa-83 sweet potato.

3.2.3. Shoot Fresh Weight

The analysis of variance revealed that both farmyard manure and nitrogen fertilizer had a highly significant effect ($p < 0.001$) on the shoot fresh weight of sweet potato. Additionally, the interaction between the two fertilizers also significantly influenced ($p < 0.05$) the shoot fresh weight (Table 1). The highest shoot fresh weight (1009.6 g hill⁻¹) was recorded with the combined application of 100 kg nitrogen ha⁻¹ and 10 t farmyard manure ha⁻¹. In contrast, the lowest fresh shoot weight (109.8 g hill⁻¹) was observed in the control treatments (Table 1). This suggests that the shoot fresh weight is strongly influenced by higher levels of farmyard manure application, likely due to the nutrient composition of the manure. These results align with findings from [13], which reported that sweet potato fresh weight is highly responsive to increased levels of farmyard manure. Similarly, increasing nitrogen levels from 0 to 90 kg N ha⁻¹, in combination with 0 kg P ha⁻¹ on flat seedbeds, resulted in a significant increase in shoot fresh weight (g hill⁻¹). The maximum shoot fresh weight was recorded on a ridge seedbed (578 g hill⁻¹) at 90 kg N ha⁻¹ and 25 kg P ha⁻¹, and on a flat seed-

bed (545 g hill⁻¹) at 90 kg N ha⁻¹ and 0 kg P ha⁻¹.

3.2.4. Shoot Dry Weight of Sweet Potato

The analysis of variance revealed that the shoot dry weight of sweet potato was highly significantly ($P < 0.01$) influenced by the interaction of Nitrogen and farmyard manure fertilizer. The highest shoot dry weight of sweet potato (141.35 g hill⁻¹) was recorded at combination of 10 t ha⁻¹ farmyard manure and 100 kg nitrogen fertilizer which was 129.50 % higher than the control (0 t ha⁻¹ FYM and 0 kg Nitrogen). It was followed by the value (139) obtained as the result of combined application of 5t ha⁻¹ FYM and 100 kg ha⁻¹ of nitrogen fertilizer. The least days to physiological maturity (61.6 g hill⁻¹) was obtained from the control (Table 1). Girma [14] also reported that the underground biomass of potato was increased due to application of 138 kg ha⁻¹ of nitrogen fertilizer. The positive effects of N on fresh and dry root weight increase could be attributed to more interception of photo-synthetically active radiation, higher dry matter accumulation, and partitioning to the root portion [15].

Table 1. The interaction effect of applied farmyard manure (t ha⁻¹) and organic nitrogen (kg⁻¹) fertilizer on growth parameter like vine length, Shoot Fresh Weight, Shoot Dry Weight, Days to 50% bud Sprouting, DPM = Days to Physiological Maturity, NBPP= Number of branch per plant of sweet potato at Mulo during the 2020/2021.

Treatments		Growth parameter and Phenological variables					
FYM (t ha ⁻¹)	N (kg ha ⁻¹)	VL	SHFW	SHDW	DBS	DPM	NBPP
0	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
	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	134.5 ^c	6.48 ^{cd}
	100	153.43 ^b	870 ^b	139 ^a	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

Keys: means sharing common letter(s) are not significantly different at 5% level of Significance FYM = farmyard manure, N=Nitrogen, VL=Vine length, SHFW=Shoot Fresh Weight, SHDW= Shoot Dry Weight, DBS=Days to 50% bud Sprouting, DPM = Days to Physiological Maturity, NBPP= Number of branch per plant CV =Coefficient of Variation, LSD= Least Significance Difference.

3.2.5. Tuberous Storage Tuber Diameter

The analysis of variance revealed that the storage root diameter of sweet potato was highly significantly ($P < 0.01$) influenced by the interaction of Nitrogen and farmyard manure fertilizer. The highest storage root diameter of sweet potato (22.5cm) was recorded at combination of 10 t ha⁻¹ farmyard manure and 100 kg nitrogen fertilizer which was 44.23% higher than the control (0 t ha⁻¹ FYM and 0 kg Nitrogen). It was followed by the value (21.8 cm) obtained as the result of combined application of 10t ha⁻¹FYM and 70 kg ha⁻¹ of nitrogen fertilizer. The least days to physiological maturity (15.6cm) was obtained from the control (Table 2). This may be due to the fact that FYM improves the fertility of the soil through decomposition by soil microbes making nutrients available for sweet potato uptake which enhances vegetative growth and partitioning of assimilate in storage roots yield. [16] Found that FYM at 5 t ha⁻¹ produced maximum tuberous root diameter, fresh root yield, and marketable root yield of potato. Similarly, [17] indicated that the application of vermicomposting led to an increase in tuber diameter of sweet potato.

3.2.6. Biomass Yield

The analysis of variance revealed that the biomass yield was highly significantly ($P < 0.01$) influenced by the interaction of Nitrogen and farmyard manure fertilizer. The highest biomass yield of sweet potato (1009.2 t/ha) was recorded at combination of 10 t ha⁻¹ farmyard manure and 100 kg Nitrogen fertilizer which was 44.23% higher than the control (0 t ha⁻¹ FYM and 0 kg Nitrogen). It was followed by the value (928 tha⁻¹) obtained as a result of combined application of 10t ha⁻¹FYM and 70 kg ha⁻¹ of nitrogen fertilizer. The least biomass yield (579.7 tha⁻¹) was obtained from the control (Table 2). This great difference result might be due to that organic substance like farmyard manure enables suitable soil structure for the crop. According to [18], shoot fresh weight of sweet potato was influenced by the highest level of farm yard manure.

3.2.7. Harvest Index

The present study revealed that the harvest index was highly significantly ($P < 0.01$) influenced by the interaction of Nitrogen and farmyard manure fertilizer. The highest harvest index value of (0.36) was recorded due to combination application of 10 t ha⁻¹ farmyard manure and 100 kg Nitrogen fertilizer which was 70.56 % higher than the control. It was followed by the value (7.06) obtained as a result of combined application of 5t ha⁻¹FYM and 100 kg ha⁻¹ of nitrogen fertilizer. The least value (0.28%) of the harvest index was obtained from the control (Table 2). The harvest index was proportional to marketable and total fresh storage root yield in ton ha⁻¹ and also with marketable and total fresh storage weight per plant. It was also the result of marketable storage root number, total storage root number, and storage

root length. It was inversely proportional to the above ground fresh biomass weight. In line with this, [19], found that N and P application resulted in significant differences in fresh weight harvest index. As the combination levels of N and P increased beyond 45 N kg ha⁻¹ and P levels from 25 to 75 P kg ha⁻¹, a significant decrease in fresh weight harvest index was recorded. He further indicated that increasing N levels from 0 to 45N kg ha⁻¹ and P levels at 0 –23 P kg ha⁻¹, recorded the maximum fresh weight base harvest index.

Table 2. The interaction effect of applied FYM (t ha⁻¹) and organic N (kg⁻¹) on Yield parameter Total Storage, root diameter, Harvest index, and Biomass yield of sweet potato at Mulo during 2020/2021 under rainy season.

Treatments		Yield parameter		
FYM t ha ⁻¹	N Kg ha ⁻¹	TSTD	HI	BMV
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 ^{bcd}	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
10	0	20.2 ^{abc}	0.31 ^{de}	703.3 ^{de}
	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, FYM = farmyard manure, N=Nitrogen, RFW=Root fresh weight, RDW=Root dry weight, TSRD=Total Storage root diameter, HI= Harvest index and BMV= Biomass yield, CV =Coefficient of Variations, LSD= Least Significance Difference.

3.2.8. Marketable Tuber Number

The present study revealed that the marketable tuber root number was highly significantly ($P < 0.01$) influenced by the interaction of Nitrogen and farmyard manure fertilizer. The highest marketable tuber root number value of (3.2 t/ha) was recorded due to combination application of 10 t ha⁻¹ farmyard manure and 100 kg nitrogen fertilizer which was 291 % higher than the control (0 t ha⁻¹ FYM and 0 kg Nitrogen). It

was followed by the value (3.05) obtained as a result of combined application of 5 t ha⁻¹ FYM and 100 kg ha⁻¹ of nitrogen fertilizer. The least value (0.83 t/ha) of marketable tuber root number was obtained from the control (Table 3). The marketable tuber number plant⁻¹ increased with increasing farmyard manure application rate because the farmyard manure applied to soil resulted in an increase in carbon mineralization in the soil due to available carbon for microbial respiration and provision of nitrogen. The possible reasons for the maximum marketable number of tubers per hill observed from the higher combined application of nitrogen fertilizer and farmyard manure could be due to the presence of adequate amount of nitrogen which resulted in better vegetative growth, greater photo assimilating for the production of marketable tuber numbers. The high total and marketable tuber yields obtained due to the combined use of mineral and organic fertilizers could be attributed to the synergetic effect of mineral NPS and Cattle Manure [20].

3.2.9. Unmarketable Tuber Number

The analysis of variance revealed that the main effect of farmyard manure and nitrogen fertilizer was highly significantly ($p < 0.001$) affecting on the unmarketable tuber number of sweet potato. However, the interaction effects of the two fertilizers significantly ($p < 0.05$) affecting the unmarketable tuber root number of sweet potato. The maximum tuber root number per plant (0.38) was recorded at 10 t farmyard manure ha⁻¹ + 100 kg nitrogen fertilizer ha⁻¹ and the lowest yield (0.02) was recorded at 0 t FYM ha⁻¹ + 0 kg nitrogen ha⁻¹ fertilizer (Table 3). The result indicated that as the yield of sweet potato increased due to increasing rates of FYM and

nitrogen fertilizer application. This may be due to nutrient addition by applying FYM which enriches the soil for the uptake of macro and micro nutrients which are important for increasing tuber yield. [21] reported a 29% yield increase (marketable and unmarketable tubers) due to supplementing 50 t FYM ha⁻¹ in potato over FYM untreated control. The increase in unmarketable was due to insect pests like beetles which made the tubers shapeless and considered as unacceptable in the market which should be controlled by integrated pest management system.

3.2.10. Total Tuber Yield

The analysis of variance showed that the main effect of farmyard manure and inorganic N fertilizer was highly significantly ($p < 0.001$) affecting on the total tuber yield of sweet potato. However, the interaction effects of the two fertilizers were significantly ($p < 0.05$) affecting the marketable root yield of sweet potato. The maximum tuber yield per hectare (22.45 t ha⁻¹) was recorded at 10 t FYM ha⁻¹ + 100 kg N ha⁻¹ and the lowest yield (7.05 t ha⁻¹) was recorded at 0 t FYM ha⁻¹ + 0 kg N ha⁻¹ (Table 3). The large yield gap between the treatments may be due to the low fertility of the experimental site which resulted the lowest yield of control. The highest yield response with the highest rates of combined application of nitrogen and farmyard manure might be due to an initial fast release of nutrients to plants from the inorganic nitrogen, prior to the release of nutrients from the organic sources, thereby, solving the characteristic shortcoming of slow initial release of nutrients from sole organic manure application [22].

Table 3. The interaction effect of applied farmyard manures (t ha⁻¹) and organic N (kg ha⁻¹) on Total yield, Marketable yield, and unmarketable yield of sweet potato at Mulo during 2020/2021 under rainy season.

Treatments		Yield parameter				
FYM (t ha ⁻¹)	N (kg ha ⁻¹)	TTY	MTY	UMTY	MSTN	UMSTN
0	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}	0.28 ^{bcd}
	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
10	0	13.75 ^{ef}	11.95 ^{ef}	1.30 ^d	1.75 ^{ef}	0.21 ^{cd}
	40	16.23 ^{cde}	14.55 ^{cde}	1.34 ^d	2.12 ^{cde}	0.21 ^{cd}
	70	21.44 ^{bc}	18.45 ^{bc}	1.27 ^d	2.76 ^{bc}	0.22 ^{cd}

Treatments		Yield parameter				
FYM (t ha ⁻¹)	N (kg ha ⁻¹)	TTY	MTY	UMTY	MSTN	UMSTN
	100	22.45 ^a	21.85 ^a	0.31 ^e	3.2 ^a	0.02 ^e
LSD (0.05)		4.76	5.90	2.11	3.22	1.30
CV %		6.25	7.90	13.23	8.89	9.16

Key means sharing common letter(s) are not significantly different at 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

4. Conclusion

The results study revealed that the combined application of nitrogen fertilizer and farmyard manure fertilizers were highly significantly ($p < 0.01$) affected most of the growth, yield and yield component of sweet potato. The interaction effects of the two factors also affected most of the growth as well as yield parameters significantly ($p < 0.05$). Integrated application of 10t ha⁻¹ farmyard manure and 100 kg/ha of nitrogen fertilizer resulted large differences as compared with untreated plots. Therefore, the highest and lowest vine length (160.23 and 112.17 cm), shoot fresh weight (1009.6 and 109.8 g hill⁻¹), shoot dry weight (141.35 and 61.6 g hill⁻¹), days of bud sprouting (13.27 and 6.34), days of physiological maturity (147.8 and 119), number of branches per plant (7.30 and 4.28), harvest index (0.36 and 0.28%), biomass yield (1009.2 and 579.7 t/ha), tuberous storage tuber diameter (22.5 and 15.6 cm), total tuber yield (22.45 and 7.05 t/ha), marketable tuber yield (21.85 and 7.65 t/ha), unmarketable tuber yield (3.25 and 0.31 t/ha), marketable storage tuber number (3.2 and 0.83), (and) and un marketable tuber number (0.38 and 0.02) were recorded due to combined application of 100 kg/ha of nitrogen fertilizer plus 10 t/ha of farmyard manure fertilizer and at control level respectively. However, these results are reverse for the number of branches per plant, unmarketable tuber number, and unmarketable tuber yield. Generally, the present study indicated that the combined application of nitrogen and farmyard manure fertilizer improved the growth, yield, and yield components of sweet potato. Accordingly, the optimum tuber yield was obtained from combined application of 100 kg ha⁻¹ N fertilizer and 10t ha⁻¹ farmyard manure. Moreover, farmers in the study area should be encouraged to use an integrated nutrient management system rather than the sole application of inorganic and organic fertilizers and that why they also improve the physicochemical properties of the soil, thereby significantly enhancing the growth, yield and yield component of sweet potato.

Abbreviations

P	Phosphorus
T	Tone
Ha	Hectare
Kg	Kilogram
CM	Compost

Author Contributions

Alemu Hailu Deme: Conceptualization, Data curation, Formal Analysis, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

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Conflicts of Interest

The authors declare no conflicts of interest.

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