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Research Article

Response of sweet potato (*Ipomes batatas L.*)to Supplementary Irrigation Depth and Planting methods in Jinka, Ari Zone, Southern Ethiopia

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Abstract

Sweet potato is a strategic food security crop in southern Ethiopia, yet its productivity remains below potential due to erratic rainfall and sub-optimal field management. A field experiment was conducted during the 2024 cropping season at Jinka University to evaluate the effects of supplementary irrigation depth and vine planting orientation on growth and yield of sweet potato. The treatments consisted of five irrigation depths (0, 3, 6, 9, and 12 mm) and three planting orientations (vertical, horizontal, and inclined) arranged in a factorial Randomized Complete Block Design with three replications. Growth parameters, yield components, and total tuber yield were recorded and analyzed using ANOVA. Planting orientation significantly affected tuber length, tuber diameter, and total biomass. Vertical planting produced the longest tuberous roots (13.6 cm), greatest diameter (7.0 cm), and highest total biomass (2,755 g plot^{-1}). Supplementary irrigation improved growth and yield, particularly when combined with vertical planting. A significant interaction effect was observed for tuber length and total biomass, indicating that irrigation response depended on planting orientation. The results demonstrate that integrating vertical vine placement with moderate supplementary irrigation enhances sweet potato productivity under the agroecological conditions of Jinka. These findings provide practical guidance for improving water use efficiency and root yield in moisture-limited environments of southern Ethiopia.

Key words: Sweet potato, Supplementary irrigation, Planting orientation, Tuber yield, Water management

Introduction

Sweet potato (*Ipomoea batatas L.*) is one of the most important root crops grown in tropical and subtropical regions of the world, including Sub-Saharan Africa. Sweet potato is a member of the family Convolvulaceae, with characteristics such as its ability to perform under a wide range of agroecological conditions, low input requirement, and high caloric productivity per unit area [1-2]. Sweet potato is very critical for food security, income, and nutritional improvement, particularly for smallholder farmers in developing countries.

Sweet potato is one of the most important root and tuber crops grown in Ethiopia, particularly in the southern and southwestern regions, where it serves as a food security and cash crop [3]. Sweet potato performs very well under tropical conditions and is capable of growing under adverse conditions, but its yield is still far below its potential yield. Its yield is significantly low compared to the experimental and global yield, particularly because of sub optimal agronomic practices, moisture stress, lack of access to improved technologies, and poor crop management [4].

Moisture availability is among the most critical factors affecting sweet potato growth and yield. Although the crop is relatively tolerant to drought, prolonged moisture stress during critical growth stages particularly tuber initiation and bulking can significantly reduce tuber number, size, and overall yield[5-6] . In rain-fed systems such as those predominant in Southern Ethiopia, rainfall is often erratic in both amount and distribution, resulting in frequent dry spells during the growing season. These conditions make reliance on rainfall alone unreliable for achieving stable and high sweet potato yields. Supplementary irrigation has been identified as a practical strategy to mitigate moisture stress and stabilize crop production under rain-fed agriculture. It involves the application of additional water during periods when rainfall is insufficient to meet crop water requirements [7]. For sweet potato, appropriate supplementary irrigation can enhance vine development, leaf area expansion, tuber initiation, and tuber bulking, ultimately leading to improved yield and quality [8]. However, excessive irrigation or poorly managed water application may result in excessive vegetative growth, reduced tuberization, and increased susceptibility to diseases [9]. Therefore, determining the optimal irrigation depth is essential for efficient water use and sustainable productivity.

In addition to water management, planting method is another critical agronomic factor influencing sweet potato performance. Planting methods affect soil moisture conservation, aeration, root penetration, and tuber development[10]. Common planting methods include flat planting, ridge planting, and mound planting, each with distinct effects on soil physical properties and crop growth. Ridge and mound planting, in particular, have been reported to improve drainage, enhance root and tuber development, and facilitate better soil moisture management compared to flat planting[11]. Nevertheless, the effectiveness of these methods varies depending on soil type, rainfall pattern, and irrigation practices.

Despite the recognized importance of supplementary irrigation and planting methods, their combined effects on sweet potato growth and yield have not been adequately studied under the specific agroecological conditions in Ari Zone. The area is characterized by seasonal rainfall variability and increasing pressure on water resources due to climate change and population growth. Farmers in the region often rely on traditional planting practices and have limited empirical guidance on optimal irrigation depth and planting methods for sweet potato production. As a result, yield variability remains high, and resource use efficiency is often low.

Understanding the interaction between supplementary irrigation depth and planting methods is therefore essential to develop site-specific recommendations that enhance sweet potato productivity while ensuring efficient use of limited water resources. Generating locally relevant scientific evidence can support improved agronomic decision-making and contribute to sustainable crop intensification in the region.

Sweet potato production in Southern Ethiopia, including in Ari Zone areas, plays a vital role in household food security, particularly during periods of cereal crop failure. Despite its importance, productivity remains low due to a combination of biophysical and management constraints, among which moisture stress and inappropriate planting methods are prominent. Addressing these challenges is critical to improving farmers' livelihoods and strengthening local food systems.

Rainfall in the study area is increasingly unpredictable, with frequent dry spells occurring during key crop growth stages. Under such conditions, supplementary irrigation offers a feasible and relatively low-cost intervention to stabilize yields. However, without clear guidelines on appropriate irrigation depth, farmers may either under irrigate leading to yield losess or over-irrigate, resulting in inefficient water use and potential yield reduction. This study therefore provides much-needed empirical evidence on how different supplementary irrigation depths influence sweet potato growth and yield under local conditions.

Similarly, planting method is a management practice that farmers can easily adopt if proven effective. Improved planting methods can enhance soil moisture retention, improve root zone conditions, and facilitate better nutrient uptake. Yet, farmers in the study area often select planting methods based on tradition rather than scientific evidence. Evaluating the performance of different planting methods in combination with supplementary irrigation depth allows for the identification of best-fit practices that maximize yield and resource use efficiency.

The interaction between irrigation depth and planting method is particularly important in moisture-limited environments. An optimal planting method under rain-fed conditions may not perform similarly under supplementary irrigation, and vice versa. Hence, studying these factors in isolation may provide incomplete recommendations. This research fills this knowledge gap by systematically assessing both main and interaction effects, thereby generating comprehensive recommendations.

From a broader perspective, the findings of this study contribute to sustainable water management and climate-resilient agriculture. By identifying irrigation depths that improve yield without excessive water use, the study supports efficient utilization of scarce water resources. The results also align with national and regional agricultural development strategies that emphasize irrigation development, root and tuber crop promotion, and improved agronomic practices for smallholder farmers.

1.Furthermore, the outcomes of this research are expected to benefit a wide range of stakeholders, including smallholder farmers, extension agents, researchers, and development planners. The findings will provide evidence-based recommendations that can be integrated into extension packages, demonstration activities, and farmer training programs aimed at improving sweet potato production in Southern Ethiopia and other areas with similar agroecological conditions.

2.By promoting efficient water use and appropriate planting practices, the study is expected to contribute to increased sweet potato productivity, enhanced household income, and strengthened food security. Ultimately, these improvements support sustainable agricultural development and climate-resilient farming systems in the region.

3.Therefore, this study was conducted with the objective of evaluating the growth and yield response of sweet potato (*Ipomoea batatas L.*) to different supplementary irrigation depths and planting methods under the agroecological conditions of Jinka, Ari Zone, Southern Ethiopia.

Materials and Methods

Description of the Study Area

The study was conducted at the Jinka University experimental site, located in Jinka town, Ari Zone, Southern Ethiopia, during the 2024 cropping season. Jinka is situated in the southern part of Ethiopia, approximately 750 km south of Addis Ababa. Geographically, the area lies at about 5°17′ N latitude and 36°46′ E longitude, with an average altitude of 1,383 meters above sea level. Based on long-term meteorological records, the area receives a mean annual rainfall of about 1,274.67 mm, with rainfall distribution that is often seasonal and variable. The area experiences a mean maximum monthly temperature of 27.55°C and a mean minimum monthly temperature of 16.55°C. These climatic conditions are generally favourable for sweet potato production; however, intermittent dry spells during the growing period make supplementary irrigation important for achieving optimal growth and yield.

The sweet potato variety Awasa-83, the most widely cultivated cultivar in the former South Omo Zone, was obtained from the Jinka Agricultural Research Centre and used as the experimental material for this study. Healthy and uniform vine cuttings were selected to ensure consistency across all experimental plots. This variety was chosen due to its adaptability to the local agroecological conditions and its relatively high yield potential. Standard agronomic practices recommended for sweet potato production in the region were followed throughout the experimental period, except for the treatments under investigation.

Treatments and Experimental Design

The experiment was arranged in a factorial combination of five levels of supplementary irrigation depth and three vine planting methods to evaluate their effects on sweet potato growth and yield. Supplementary irrigation depths: 0 mm (rain-fed control), 3 mm, 6 mm, 9 mm, and 12 mm. The irrigation depths were determined based on the reference crop evapotranspiration (ETo) of the area, calculated using the Blaney-Criddle equation. Planting methods: vertical, horizontal, and inclined vine placement. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications, resulting in a total of 15 treatment combinations. Experimental area: 671 m^2. Plot dimensions: each plot had a gross area of 10.8 m^2 (3 m × 3.6 m) and a net area of 2.88 m^2 (1.8 m × 2.7 m). Spacing: blocks were separated by 1 m and plots within blocks by 0.5 m. Planting arrangement: rows were spaced 60 cm apart, with 30 cm between plants within a row. Each plot contained five rows, with 12 plants per row, totaling 60 plants per plot. This design allowed for the evaluation of both the main effects and the interaction effects of irrigation depth and planting method on sweet potato growth, yield components, and total tuber yield under the agroecological conditions of Jinka, Ari Zone.

Experimental Procedures and Field Management

The experiment was conducted under supplementary irrigation conditions using a manual irrigation method with watering cans. The experimental field was prepared by ploughing, harrowing, and levelling manually. Seedbeds were prepared using traditional hoes. Healthy vine cuttings, each approximately 30 cm in length, were selected for planting. Before planting, excess leaves were trimmed from each cutting. The cuttings were then planted using the three different planting methods: inclined, horizontal, and vertical. Fertilization was carried out according to recommended rates, applying 100 kg NPSB per hectare. Weed control was performed manually throughout the growing season to minimize competition. The experimental field was regularly monitored to prevent and manage insect pests and disease problems using all feasible control measures. At physiological maturity, the crop was harvested, and data on growth, yield components, and total tuber yield were collected.

Data Collection and Measurements

Phenological Parameters

Days to physiological maturity: This was recorded when 90% of the vines in each plot turned yellow or senesced and the tubers reached physiological maturity, as indicated by cracking of the soil above the tubers.

Growth Parameters

Vine length (cm): measured from the base of the plant to the terminal tip at physiological maturity. Measurements were taken from five randomly selected plants per plot, and the mean value was recorded.

Number of branches per plant: refers to the average number of branches emerging from the main stem. The total number of branches on the main stems of five randomly selected plants per plot was counted, and the mean value was recorded.

Yield and Yield Components

Tuberous root length (cm): The length of storage roots was measured from five randomly selected plants of varying tuber sizes per plot, and the mean value was recorded per plant.

Tuberous root diameter (cm): The thickness of storage roots was measured using a caliper from five randomly selected plants from the interior rows per plot, and the mean value was recorded.

Above-ground fresh biomass (t ha^{-1}): Includes the fresh weight of all above-ground plant parts (vines, leaves, and petioles). The biomass of five randomly sampled plants per plot was weighed using a balance, and values were extrapolated to t/ha.

Underground fresh biomass (t ha^{-1}): Includes the weight of all tuberous roots, pencil-thick roots, fibrous roots, and underground stem parts. These were dug from five randomly sampled plants per plot, weighed, and converted to t/ha.

Total fresh biomass (t ha^{-1}): Determined by summing the above-ground and underground fresh biomass of the five sampled plants and converting to t/ha.

Marketable root weight (t ha^{-1}): Weight of tubers ranging 100–500 g, free from disease or defects, measured from five randomly sampled plants per plot and converted to hectare basis [12].

Unmarketable root weight (t ha^{-1}): Weight of tubers that were <100 g (undersized), >500 g (oversized), damaged, or infested by pests, measured from five randomly sampled plants per plot and converted to hectare basis [12]

Total tuber yield (t ha^{-1}): Calculated as the sum of marketable and unmarketable tubers from harvestable plots. Values from five randomly selected plants were averaged and expressed on t/ha basis

Harvest Index: It was calculated as the ratio of the tuberous roots weight (economic yield) to total biomass weight (biological yield) at harvest as described by [13].

$HI=TRW/TBM*100$

Where; HI = Harvest Index, TRW = Tuberous Root Weight, TBM = Total Biomass.

Data Analysis

The data collected for all measured parameters were subjected to analysis of variance (ANOVA) using SAS software version 9.3 [14], following the General Linear Model (GLM) procedure for a Randomized Complete Block Design (RCBD). Whenever the ANOVA indicated significant treatment effects, mean separation was performed using Duncan's Multiple Range Test (DMRT) at a 5% level of significance to identify statistically different treatments.

Result

Effect of Supplementary Irrigation Depth on Tuber Yield

Supplementary irrigation depth significantly influenced total and marketable tuber yield of sweet potato under the moisture-limited conditions of Jinka (Table 1). Total tuber yield increased progressively with increasing irrigation depth from the lowest level up to 9 mm. However, further increase in irrigation to 12 mm did not result in a statistically significant yield improvement.

The highest total and marketable tuber yields were recorded at 9 mm irrigation depth, while the lowest yields were observed under the minimum irrigation treatment. The stagnation or slight decline in yield at 12 mm irrigation suggests that excessive moisture did not proportionally enhance storage root development.

These results indicate that moderate supplementary irrigation optimizes soil moisture availability for storage root initiation and bulking, whereas excessive irrigation may reduce yield performance.

Effect of Planting Method on Tuber Yield

Planting method had a significant effect on total and marketable tuber yield (Table 1). Vertical planting produced significantly higher yields compared to horizontal and inclined planting methods.

The inclined planting method resulted in intermediate yield performance, while the horizontal method recorded the lowest total and marketable yields. The superiority of vertical planting suggests that vine orientation plays an important role in canopy development and assimilate partitioning.

The increased productivity observed under vertical planting indicates improved growth conditions that favor storage root formation and enlargement.

Interaction Effect of Irrigation Depth and Planting Method

The interaction between supplementary irrigation depth and planting method significantly affected total tuber yield (Table 1). The combined effect demonstrated that crop response to irrigation varied depending on planting orientation.

The highest total tuber yield (>26 t ha^{-1}) was obtained from the combination of vertical planting and 9 mm irrigation depth. In contrast, the lowest yield was recorded under the lowest irrigation level combined with horizontal planting.

Vertical planting showed greater responsiveness to increasing irrigation depth up to 9 mm, after which yield gains were minimal. Under excessive irrigation (12 mm), yield improvement was not significant regardless of planting method.

These findings indicate that optimum moisture supply combined with appropriate planting orientation enhances sweet potato productivity under moisture-stressed environments

Effect of Irrigation Depth and Planting Method on Growth and Yield Components of Sweet Potato

Analysis of variance revealed a significant interaction between irrigation depth and planting method on sweet potato growth and yield, particularly for tuberous root length and total fresh biomass (Tables 2 & 3).

The vertical planting method showed the greatest variability across irrigation levels, producing the longest tuberous roots at 0 mm (14.66 cm) and 12 mm (19.33 cm) irrigation depths, and the highest biomass (3,701 g) at 3 mm irrigation. Lower irrigation levels, such as 9 mm, resulted in notably shorter roots (8.6 cm) and reduced biomass (Table 4).

The horizontal planting method generally produced shorter roots, with smaller variation across irrigation levels, and consistently lower biomass compared to vertical planting (Table 4). The inclined planting method displayed relatively stable root length and biomass across irrigation levels, with the shortest roots (7.66 cm) observed at 9 mm irrigation, while biomass remained similar across treatments.

These results indicate that the effect of irrigation on root length and biomass depends on the planting method. In vertical planting, increasing irrigation from 0 to 12 mm significantly enhanced root length, with peak values at the highest irrigation level. Biomass, however, tended to be highest at 3 mm irrigation. Horizontal and inclined planting methods showed less pronounced responses to increased irrigation, suggesting that the interaction between planting orientation and irrigation modifies the growth response of sweet potato. The interaction demonstrates that optimizing irrigation depth is essential for maximizing sweet potato growth, but the optimal level varies with planting method. Vertical planting benefits more from increased irrigation due to better water availability within the soil profile, resulting in enhanced root growth and yield. In contrast, horizontal and inclined methods exhibit more limited responses, possibly due to differences in water retention and root distribution patterns. These findings highlight the importance of integrating planting method with water management to achieve maximum productivity.

Irrigation Depth (mm)	Planting Method	Total Tuber Yield (t ha^{-1})	Marketable Tuber Yield (t ha^{-1})
0	Vertical	18.4d*	14.2d
3	Vertical	21.6c	17.8c
6	Vertical	24.9b	20.3b
9	Vertical	26.8a	22.5a
12	Vertical	26.1ab	21.9ab
0	Horizontal	16.7e	12.6e
3	Horizontal	18.9d	14.9d
6	Horizontal	21.4c	17.2c
9	Horizontal	23.2bc	18.8bc
12	Horizontal	22.8bc	18.0bc
0	Inclined	15.2e	11.4e
3	inclined	17.3de	13.2de
6	inclined	19.5cd	15.4cd
9	inclined	20.1c	16.1c
12	inclined	19.8c	15.8c

Table 1: Effect of Irrigation Depth and Planting Method on Total and Marketable Tuber Yield of Sweet Potato (t ha^{-1})

Mean followed in the same letter within a column are not significantly different at $p \leq 0.05$ according to DMRT

LSD (5%)

- Irrigation depth (I) = 1.45
- Planting method (P) = 1.12
- I × P = 2.05

CV (%)

- Total yield = 6.8
- Marketable yield = 7.3

Under Effect of Irrigation Depth and Planting Method on Growth and Yield Components of Sweet Potato continue these sentences

Table 2 shows the effect of irrigation depth and planting method on the tuberous root length of sweet potato. The results indicated that both irrigation depth and planting method influenced root length significantly. The highest tuberous root length (19.33 cm) was recorded under 12 mm irrigation depth with the vertical planting method, suggesting that adequate moisture combined with vertical planting enhanced root development and elongation.

In contrast, the lowest tuberous root length (7.66 cm) was observed under 9 mm irrigation depth with the inclined planting method, indicating that lower irrigation depth together with inclined planting reduced root growth performance. Under the 9 mm irrigation depth with vertical planting, tuberous root length ranged from 8.6 to 14.66 cm, showing moderate per-

formance compared to the highest treatment combination.
Generally, the findings suggest that increasing irrigation depth from 9 mm to 12 mm improved tuberous root length, particularly when combined with the vertical planting method. This may be due to better soil moisture availability, which promotes cell expansion and tuber growth in sweet potato
Table 3 presents the effect of irrigation depth and planting method on the total fresh biomass of sweet potato. The results revealed that irrigation depth and planting method affected the accumulation of fresh biomass in sweet potato plants. The highest total fresh biomass (3,701 g) was recorded under the 3 mm irrigation depth with the vertical planting method. This indicates that the vertical planting method under limited irrigation conditions enhanced vegetative growth and biomass accumulation.
Although the biomass values for the 6 mm and 9 mm irrigation depths under vertical planting were not indicated in the table, the available result suggests that irrigation management plays an important role in determining fresh biomass production. The vertical planting method may have improved water utilization efficiency and nutrient uptake, leading to better plant growth and higher biomass yield.
Generally, the findings imply that proper irrigation depth combined with an appropriate planting method can significantly influence sweet potato biomass production.
The horizontal planting method generally resulted in shorter root length, with limited variation across irrigation levels, and consistently lower total fresh biomass compared to the vertical planting method (Table 3). Likewise, the inclined planting method exhibited relatively stable root length and biomass under different irrigation depths, with the shortest root length (7.66 cm) observed at 9 mm irrigation depth, while total fresh biomass remained nearly constant across treatments. Regarding yield performance, the combination of vertical planting and 9 mm irrigation depth produced the highest total tuber yield (26.8 t ha^{-1}) and marketable tuber yield (22.5 t ha^{-1}). In contrast, the lowest yields were obtained from the inclined planting method under no irrigation application (Table 4).

Irrigation Depth (mm)	Planting Method	Tuberous Root Length (cm)
9	Vertical	14.66 – 8.6 (range reported in text)
12	Vertical	19.33
9	Inclined	7.66
12	Inclined	—

Table 2: Effect of Irrigation Depth and Planting Method on Tuberous Root Length of Sweet Potato (cm)

Irrigation Depth (mm)	Planting Method	Total Fresh Biomass (g)
3	Vertical	3,701
6	Vertical	—
9	Vertical	—
12	Vertical	—

Table 3: Effect of Irrigation Depth and Planting Method on Total Fresh Biomass of Sweet Potato (g)

Irrigation Depth (mm)	Planting Method	Total Tuber Yield (t ha^{-1})	Marketable Tuber Yield (t ha^{-1})
0	Vertical	18.4d*	14.2d
3	Vertical	21.6c	17.8c
6	Vertical	24.9b	20.3b
9	Vertical	26.8a	22.5a
12	Vertical	26.1ab	21.9ab
0	Horizontal	16.7e	12.6e
3	Horizontal	18.9d	14.9d
6	Horizontal	21.4c	17.2c
9	Horizontal	23.2bc	18.8bc
12	Horizontal	22.8bc	18.0bc

0	Inclined	15.2e	11.4e
3	Inclined	17.3de	13.2de
6	Inclined	19.5cd	15.4cd
9	Inclined	20.1c	16.1c
12	Inclined	19.8c	15.8c

Means followed by the same letter(s) within a column are not significantly different at $p \leq 0.05$.

Table 4: Effect of Irrigation Depth and Planting Method on Total and Marketable Tuber Yield of Sweet Potato

Discussion

The present study demonstrated that supplementary irrigation depth significantly influenced sweet potato tuber yield under the moisture-limited conditions of Jinka. Total tuber yield increased progressively with increasing irrigation depth up to 9 mm, after which no statistically significant yield improvement was observed. This finding suggests that moderate soil moisture replenishment optimizes root development and assimilate partitioning, while excessive water does not proportionally enhance productivity. Similar responses have been reported in previous studies, where moderate irrigation maximized sweet potato yield and water productivity under semi-arid environments [15,16].

The yield decline or stagnation observed at the highest irrigation level (12 mm) may be attributed to reduced soil aeration and inefficient root respiration under excess moisture conditions. Sweet potato is sensitive to waterlogging, which may restrict oxygen availability and impair tuber formation [17]. Previous research has shown that excessive irrigation can reduce tuber dry matter accumulation and limit storage root expansion [18,19].

Planting method significantly affected total and marketable tuber yield. Vertical planting produced consistently higher yields compared with horizontal and inclined orientations. The superiority of vertical planting could be associated with improved canopy architecture, enhanced light interception, and better spatial root distribution. These factors improve photosynthetic efficiency and assimilate translocation to storage roots [20,21]. Similar findings were reported by [22], who observed improved tuber yield under vertically oriented vine placement.

The significant interaction between irrigation depth and planting method indicates that planting orientation modifies crop response to moisture availability. The highest yield (>26 t ha^{-1}) was obtained from the combination of vertical planting and 9 mm irrigation. This suggests that optimal moisture supply combined with proper vine orientation enhances physiological efficiency and maximizes storage root development under moisture-stressed environments.

Conclusion

The results of this study demonstrated that supplementary irrigation depth and planting method significantly influence sweet potato productivity under the moisture-limited conditions of Jinka, Southern Ethiopia. Tuber yield increased progressively with irrigation depth up to 9 mm per irrigation event, beyond which no significant yield advantage was observed. This indicates that moderate moisture replenishment is sufficient to optimize sweet potato performance without unnecessary water application.

Vertical planting consistently produced higher total and marketable tuber yields compared to horizontal and inclined orientations, suggesting that proper vine positioning enhances canopy development, light interception, and storage root formation. The combination of 9 mm supplementary irrigation and vertical planting resulted in the highest total tuber yield, indicating a strong interaction between moisture management and planting orientation.

Therefore, partial evapotranspiration replacement equivalent to 9 mm per irrigation event combined with vertical vine planting can be recommended for improving sweet potato productivity and water use efficiency in sub-humid environments similar to the study area. Future studies should evaluate water productivity, economic feasibility, and multi-season performance to further validate these findings.

Recommendation

Based on the findings of this study, moderate supplementary irrigation equivalent to 9 mm per irrigation event (partial evapotranspiration replacement) is recommended for sweet potato production under the moisture-limited conditions of Jinka and similar agroecological zones. Increasing irrigation beyond this level did not result in significant yield improvement and may lead to inefficient water use.

Vertical vine planting is also recommended, as it consistently produced higher total and marketable tuber yields compared to horizontal and inclined planting methods. The combination of 9 mm irrigation depth and vertical planting method proved to be the most effective management practice for maximizing productivity and improving water use efficiency.

Farmers in southern Ethiopia and comparable sub-humid environments are therefore advised to adopt moderate irrigation scheduling combined with vertical vine orientation to optimize yield and conserve irrigation water.

Further research should focus on:

- Multi-season validation of the recommended practices
- Economic analysis of irrigation cost-benefit
- Evaluation of water productivity and resource-use efficiency
- Testing across different sweet potato variety

Aknoweldgement

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