ZANCO Journal of Pure and Applied Sciences

TYPE Original article
DOI http://dx.doi.org/10.21271/ZJPAS.38.1.11

OPEN ACCESS

*Corresponding author
Tariq Faruq Sadiq
tariq.sadiq@su.edu.kd

RECEIVED :06 /07 /2025
ACCEPTED :03/09/ 2025
PUBLISHED :28/ 02/ 2026

KEYWORDS:
Lpomoea Batatas; Multipurpose Plant, Sugar Content; Tuber

Optimizing Harvest Time for Sweet Potato in the Kurdistan Region of Iraq

Tariq Faruq Sadiq[1&2], Masami Takahata[1], Abdulla Aram Abdulla[1], Hirokatsu Utagawa[1], Kamaran A. Abdulhameed[3], Saman Saber Ali[3], Farhad Jamal Hasan[4], Berivan Mohsin Azeez[4], Saidgwl Saida Ali[4], Salar Hussein Hasan[4], Kamaran Murshed Saleh[4]

1JICA Expert Team, Sabat Project, Erbil, Iraq
2Department of Soil and Water, College of Agricultural Engineering Sciences, Salahaddin University-Erbil, Iraq.
3 Grdarahsa Station/ Erbil Agriculture Research Center, Ministry of Agriculture and Water Resources, Erbil, Iraq.
4 Directorate of Agriculture Training Center on Region, Ministry of Agriculture and Water Resources, Erbil, Iraq.

ABSTRACT

Sweet potato [*Ipomoea batatas* (L.) Lam.] is considered a multipurpose plant with numerous applications and health benefits due to its high nutritional antioxidant, rich in fiber, and vitamins A and C. This study was conducted to determine the optimal harvesting time for sweet potato (Jewel Yams variety) cultivated for the first time in the Kurdistan Region of Iraq (KRI). The study was conducted in a RCBD (randomized block design), with five treatments which were harvested in different interval times (70, 90, 110, 130, and 150 days), 7 plants per plot, and 3 replications. After each interval of harvesting, the total yield, individual weight, size, and number of sweet potatoes per plot, as well as sweet potato quality attributes such as sugar content, were assessed using a digital refractometer (ATAGO 3810 PAL-1). The results showed that harvesting time significantly ($P \leq 0.05$) affected the yield performance of the sweet potatoes. The highest values of tuber weight (265.81 g/plant), average length (36.55 cm), width (36.35 mm), sugar content (6.34%), and total weight per plot (2.79 kg) were recorded in plots harvested 150 days (150 HD). While number of fruits per plant reached a maximum (4.86) in samples harvested after 130 days. In addition, the trends of increasing the total yield per plot compared to the earliest harvest (70 days) are as follows: 349%, 843%, 871%, and 2495% for 90, 110, 130, and 150 days, respectively. It can be concluded that harvesting times have considerable potential for enhancing sweet potato traits in terms of yield and quality. Consequently, this study suggest that farmers may base decisions upon the ultimate tuber size, degree of sweetness, and overall yield per unit area, harvesting at 130–150 days after planting, depending on the tuber maximum or quantity of interest. It is, therefore, concluded that the practice of sweet potato harvest for marketing purposes must be prolonged to 150 days for the KRI to achieve high market quality and profitability.

1.Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam.) is an important tuberous root vegetable worldwide belonging in the family Convolvulaceae. It is considered the seventh most essential staple food across the globe since it makes significant contributions to both food security and human nutrition after wheat, rice, maize, potato, barley, and cassava (Gobena, Asemie, & Firisa, 2022; Scott, 2021) . The world production is 131 million tons per year in slightly less than 9 million hectares at an average of 13.7 tons per hectare. The percentage of sweet potatoes produced in developing countries stands at about 97 percent of the global production with a large scope of cultivation predominantly in the Asian continent of which China produces 52 percent of the global production on nearly 4.7 million hectares (Nations, 2023) . There are thousands of varieties grown all over the world most centred on tropical and subtropical regions (Laurie, Van den Berg, Magoro, & Kgonyane, 2004) . Sweet potato is a very important source of carbohydrates, vitamin A and C, fiber, iron and potassium, and protein (Michael & Peter, 2023; Mukhopadhyay, Chattopadhyay, Chakraborty, & Bhattacharya, 2011; Srisuwan, Sihachakr, & Siljak-Yakovlev, 2006). It is nutritionally more energetic with a higher concentration of energy than ordinary potatoes; 100 g of sweet potato food gives 113 kcal, whereas potato (Solanum tuberosum) provides 75 kcal (Michael & Peter, 2023) . Carbohydrates in the roots amount to 25-30% with a digestibility of approximately 98 % (A. Villordon, LaBonte, & Smith, 2013), but their concentration falls within the first 60 days of storage. Both the leaves and their roots can be an excellent source of nutrients; in particular, the former contains high levels of vitamins C, B-complex, E, and K along with elevated amounts of proteins, calcium, and iron, which is why they serve as a valuable source of food as the fodder of livestock (Motsa, Modi, & Mabhaudhi, 2015)

Time of harvest is one of the most important variables that affect the harvest and quality of sweet potatoes. According to the previous literature of other territories (Bhattarai, Tripathi, Shrestha, & Gautam, 2022; Etela & Kalio, 2011; Nunes et al., 2024), the delayed harvest tends to augment the size and sweetness of the tuberous roots, but earlier harvest can result in smaller tuberous roots but can open the possibility of reaping several crops. Studies conducted in the Central Rift Valley of Ethiopia have shown that tuber yield can be substantially and consistently boosted by tuber maturity delay of 120 to 150 days after planting (DAP; e.g. 9 t/ha at 120 DAP vs 12.77 t/ha at 150 DAP), although such delay may lead to a bigger risk of pest damage (Jaleto; Meng, Dong, Li, & Zhu, 2024). Sweet potato is a new crop in Iraq, especially in the Kurdistan Region of Iraq (KRI) and little is known in terms of sweet potato production and consumption. According to a baseline survey carried out by JICA Sabat Project in 2023, there is high interest to local farmers and consumers in crop diversity with the enthusiasm identified to introduce sweet potato as a potentially successful crop (Team, 2023). Sweet potato can be grown in many environments and has demonstrated the ability to grow in poor soils under few inputs, with high caloric output due to significant yields and the provision of micronutrients, most especially when grown in orange-fleshed varieties with a higher concentration of β-carotene (Kim et al., 2018). This research hypothesize that time of harvest relatively correlates with the yield and quality characteristics of sweet potato in KRI where harvesting later (at around 150 days after transplantation) is expected to have a greater tuber size and sweetness that will fetch a higher market price. As far as we are concerned, there are no peer-reviewed studies conducted to investigate the effect of harvest timing on sweet potato yield and quality in the KRI or even in Iraqi agro-ecological areas as a whole. Despite the existence of research on the topic of sweet potato cultivation in southern Iraq (Abd, Kareem, & Lahuf, 2021; Almuoswi & Al-bideri, 2019; Hindersah, Karuniawan, & Apriliana, 2021), the studies have covered different aspects including disease control and fertilizer application instead of yield monitoring of the best time to harvest them. Subsequently, this study is the first, field- and location-specific study to optimize harvest time of sweet potato in the KRI, and the goal of this study is to make applicable

recommendations to local farmers and researchers.

2.Materials and methods

2.1Experimental site and Climate description

The experiment was conducted at the field of Director of Agriculture Training Center on Region in Erbil (TC) in the semi-arid region of KRI, from the end of April to December 2024. The TC is located at 36° 8′ 29″ N 44° 1’ 5” E with altitude of 390 masl. A composite soil samples (0-30 cm depth) collected in the experimental field prior to planting. The composite soil samples were analyzed for soil texture, pH, EC, organic matter, available N, P and K in Erbil Research Center (Soil Lab.) According to the USDA textural classification, the soil at the study location was categorized as loam, consisting of 19% clay, 37.7% silt, and 43.3% sand. With a pH of 7.97 and an electrical conductivity (EC) of 40 mS m^{-1}, it showed a slightly alkaline and low salinity. The available potassium and phosphorus were 17.00 mg kg^{-1} and 146.00 mg kg^{-1}, respectively, whereas the total nitrogen content was 0.11 g kg^{-1}. At 1.03%, the organic matter (OM) percentage was relatively low. Tariq, Abdulrahman, and Rasheed (2021) and Sadiq et al. (2025) previously reported similar results on the physical and chemical characteristics of soils from Erbil city and the same experimental field. The Department of Meteorology, General Directorate of Agriculture in Erbil (MDGDA), provided monthly meteorological data (Table 1) for the study corresponding year.

Table 1. Monthly weather during planting season of 2024 experimentation period at TC, Erbil, KRI

Month	Temperature (°C)			Avg RH_%	Avg Atm. P. (mbar)	Wind Speed (Degree)	Max wind speed (km/h)	Avg. Soil Temp. (°C)	Average Rainfall (mm)
	Avg.	Max.	Min.						
Jan	11	14.8	7.9	72.1	969.3	166.6	3.9	11.9	66
Feb	11.5	15.9	7.8	62.5	969.8	153.5	3.6	11.9	142
Mar	15	19.5	11	52.5	966.1	159	5.3	14.1	71
Aprl	24	29.2	18.3	34.3	962.9	146.9	4.8	20.3	67
May	25.7	30.7	20.6	32.7	960.5	157.7	5.3	23.5	46
Jun	35.9	41	29.8	12.9	954.9	165	4.8	28.6	
July	36.8	42.1	30.8	14.8	951.2	179.8	5.0	30.4	
Aug	36.7	42.5	30.1	14.8	954.0	180.2	4.3	30.9	
Sep	31.4	36.7	25.8	21.4	959.1	183.9	4.1	27.3	2.5
Oct	23.4	29.1	17.6	21.8	965.5	164.3	3.6	22.0	0.4
Nov	17.1	21.5	13.4	60.5	968.5	163.8	4.0	18.4	
Dec	11.2	16.4	6.9	51.4	971.5	194.0	3.0	11.0	15.8
Average	23.3	28.3	18.3	37.6	962.8	167.9	4.3	20.9	51.3

Source: MDGDA, 2025.

2.2Experimental design and layout.

The study was conducted in a RCBD (randomized block design), with five treatments which were harvested in different interval times (70, 90, 110, 130, and 150 days), 7 plants per plot, and 3 replications. Prior to planting the experimental area was cleaned from any previous plant residues, weeds, debris, etc., and then, ploughed (at depth of about 20 to 30 cm), harrowed, pulverized, and ridged (40 cm high and 60 cm apart). The experiment plot size was 2.5 m × 1 m (2.5 m^2) with 4 rows. To get vines of sweet potatoes, first 15 sweet potatoes were planted on July 2, 2024 (As sweet potato is newly introduced to the Kurdistan region, registered varieties are not yet available in the agro-markets. Only one variety, Jewel Yams, which were imported from Turkey, was grown during the planting period in this study). Then after, cutting vines on July 17, 2024, cutting vines at 30 cm long uniformly for all treatments and vines were planted about 30 cm apart in a row

spacing. Blocks were separated by 2 m, and plots were spaced 1 m apart within blocks. At transplanting the vines, each experiment units were fertilized with the recommended rate 100 kg/ha of 20-20-20 NPK fertilizer as described in Söğüt and Öztürk (2011) . During the growing season, all crop management processes, such as cultivation, irrigation and weeding were carried out as needed. To best our knowledge, this study is a part of the activities of the JICA new project ("Capacity Development Project for Agriculture Research and Extension" in KRI), which is called the Sabat Project). The Ministry of Agriculture and Water Resources of the Kurdistan Region of Iraq and the Japan International Cooperation Agency (JICA) are working together to implement the four-year Sabat Project (2022–2026). The goal of the project is to improve the technical and institutional capabilities of agricultural research centers in Germian, Zakho, Duhok, Halabja, Sulaymaniyah, and Erbil. Its main goal is to empower these centers to use research-based solutions to successfully solve farmers' production difficulties and to provide farmers with useful, scientifically supported advice through the regional agricultural extension workers.

2.3Data Collection

After each interval time (70, 90, 110, 130, and 150 days). All the seven plants per plot were observed and the average of this group was used to obtain the variable. Data on total yield, individual weight, size, number of sweet potatoes per plot, and sweet potato quality attributes such as °Brix (sugar content) were recorded. The °Brix (sugar content) were measured with a digital refractometer (ATAGO 3810 PAL-1, ATAGO Co., Ltd., Tokyo, Japan). The harvesting was done in five already decided days after transplanting; 90 days, 105 days, 120 days, 135 days, and 150 days. These were chosen fixed time points to permit appraisal of sweet potato yield and quality in terms of chronological stage, regardless of visual indices of maturity like the proportion of leaves having turned yellow (more than 50 percent), the firmness of the skin by manual rubbing, etc.

2.4Statistical analysis

All data were examined for homogeneity and normality of variances before statistical analysis. A standard deviation (SD) was calculated to represent the data's precision. Subsequently, Minitab version 16 was utilized to perform statistical analysis of variance (ANOVA) on the data at $\alpha = 0.05$. The Duncan test was then applied to compare the means.

3.Results and Discussion

3.1Sweet Potato Productivity Attributes

This study examined how sweet potato (*Ipomoea batatas* L.) yield and quality characteristics respond to different harvesting periods. The figures demonstrate data about tuber weight per plant in Figure 1 and total yield per plot in Figure 2 as well as Supplementary 1. The yield measurements showed significant differences ($p < 0.05$) between various harvesting periods. The results indicated that delaying the harvest produced higher total fruit outputs because the extended waiting period improved fruit weight outcomes. Plants that were transplanted and then waited 150 days recorded a maximum fruit weight of 265.81 g per plant^{-1}, leading to a total fruit accumulation of 2.79 kg per plot^{-1}. However, the data collected at 70 DAT (Days After Transplanted) showed the lowest measurement points, which were 23.10 g plant^{-1} and 0.11 kg plot^{-1}. This dramatical increase in yield with increasing harvesting period from 90 days to 150 days (Appendix 1) could be due to the harvesting date being delayed, providing plants enough time to collect absorbed sunlight to roots from above-ground parts. The extended photosynthesis process, combined with carbohydrate accumulation in the roots, boosts sweet potato production when harvesting occurs past maturity (Lebot, 2019) . Tuberous roots remained underdeveloped when harvested at 70 days after transplanting, as tuber bulking required additional time to develop properly. These results are consistent with those of Nedunchezhiyan, Jata, and Byju (2012) and de Albuquerque et al. (2016), who reported that sweet potato production reaches its maximum between 120–150 days after transplanting under various cultivar and environmental circumstances. However, these results disagree with those reported by Bhattarai et al. (2022) , who found that delaying harvest does not result in a

significant increase in yield, but a small increasing trend was noticed on tuber yield harvested at 150 days.

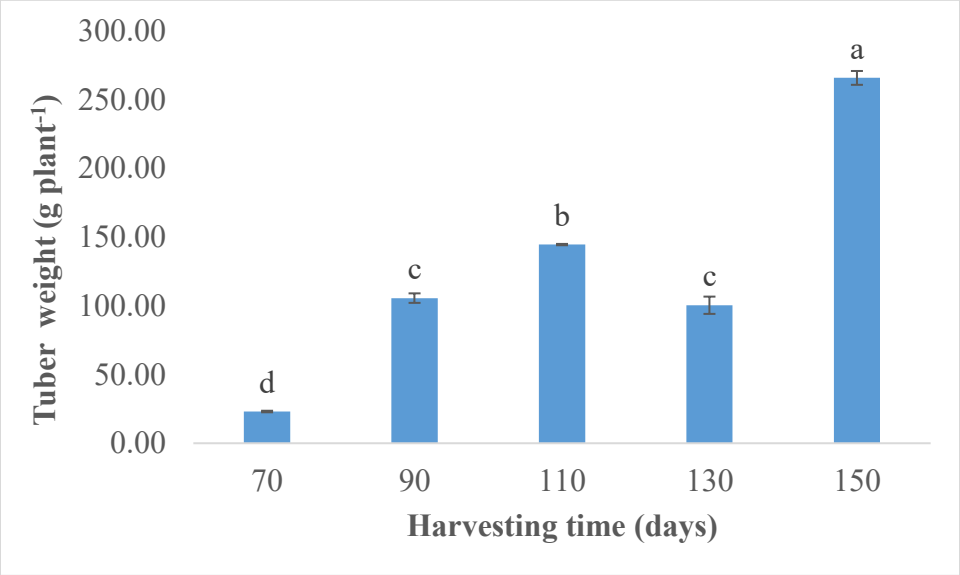

Figure 1: Sweet potatoes tuberous roots weight per plant (g plant ^{1})

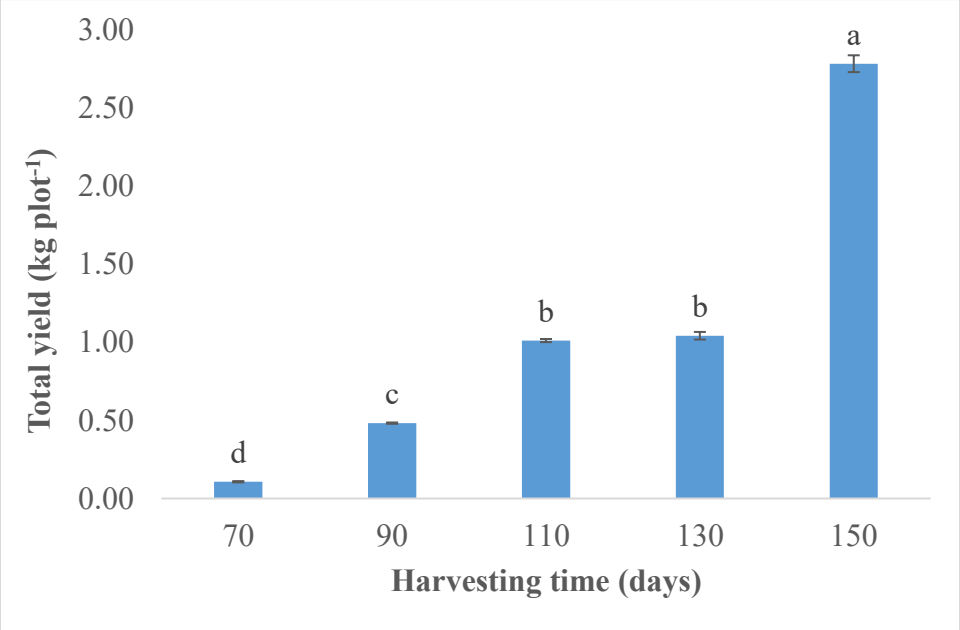

Figure 2: Total yield of tuberous roots per plot (kg plot ^{1}).

3.2Morphological Characteristics of Sweet Potatoes Fruits

The average measurements for tuberous roots length and width are presented in Figures 3, 4 and appendix 2. The dimensions of the fruit expanded continuously after harvest at different time points, reaching peak measurements (36.55 cm in length and 36.35 mm in width) at 150 days after transplanting. Starch deposition intensification in the late growth phases causes a substantial enlargement of sweet potato tuberous roots, as described by Woolfe (1992) . The measured fruit size expansion during delayed harvest periods shows that tuber development continues without interruption, influenced by the length of growth time. However, Delaying the harvesting of sweet potatoes too much could cause roots to become susceptible to weevil attacks and rotting. Research indicates that the number of fruits reaches stability after 120 days from the planting date, as tuber development halts at a critical point (Woolfe, 1992) . These results also support the previous study by Belehu (2005) and Jaleto , which found that longer growth durations for root crops promote root growth when climate conditions remain suitable.

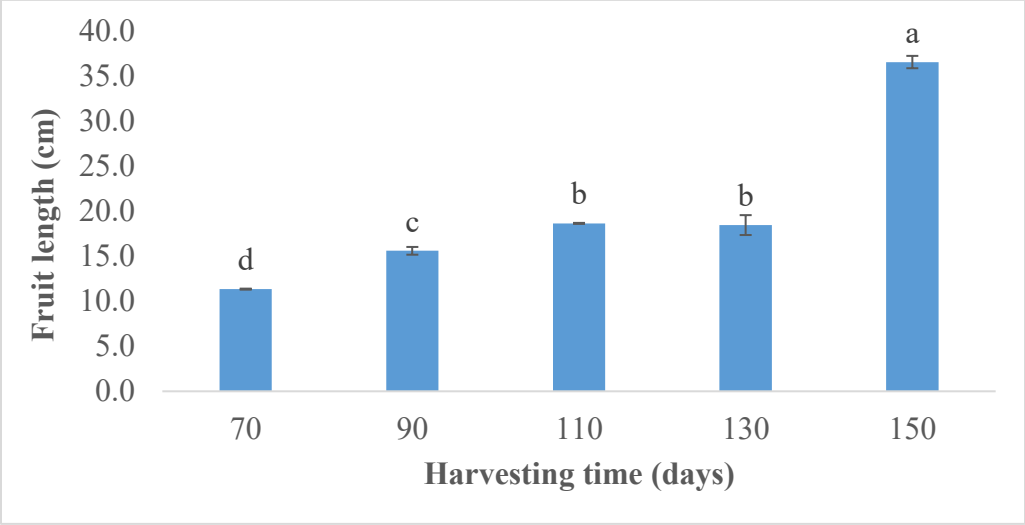

Figure 3: Average sweet potatoes tuber length (cm)

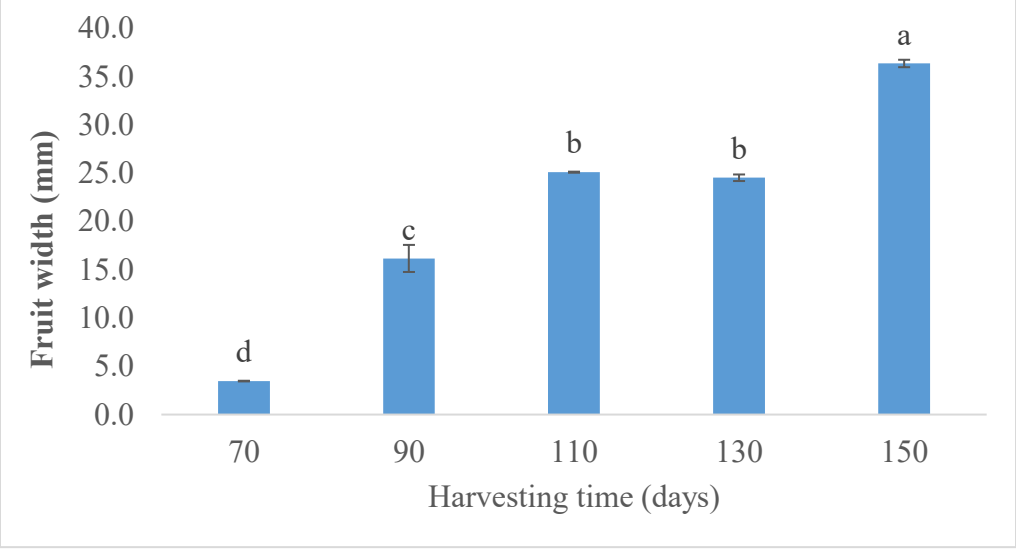

Figure 4: Average sweet potato tuber width (mm)

3.3The number of Tuberous roots and Sugar Contents

Figure 5 shows how number of tuberous roots at each harvesting date (HD) throughout the study. Harvesting at 130 days after transplanting (DAT) yielded the highest number of fruits at 4.86 per plant, marking the maximum recorded value. The sample taken at 70 DAT produced the fewest fruit numbers, with plants producing just 0.76 of them. The fruit population stabilized at 130 days after transplanting, indicating that the tuber initiation process appeared complete by that time. The results show that reproductive development extends into the 90 days while experiencing potential level-offs and reductions due to aging stages, consistent with reports by Söğüt and Öztürk (2011) and Jaleto . They obtained that number of tuberous roots, which increased significantly when harvested 120–135 days after planting but declined when delayed harvesting up to 180 days after planting.

Figure 6 shows how the sugar level (in percentage) in sweet potato fruits changes according to the time of harvest. The period of harvest directly influenced the gradual rise of sugar levels in the sweet potatoes. At 150 days after planting, sweet potato fruits achieved their maximum sugar content at 6.34%, but their minimum content reached 2.37% at day 70. The extended photosynthesis time and improved sucrose accumulation in tuberous roots explain this trend (Ishida et al., 2000; A. Q. Villordon, Ginzberg, & Firon, 2014). The maximum sugar content at 6.34% was obtained in this srudy is matched with previous results reported on commercial sweet potatoes. An estimated total sugar contents are provided (as percent of dry weight) in cultivars of fresh sweet potatoes; the values are between 4.5 (and up to about 8.4) percent (Lai YungChang, Huang CheLun, Chan ChinFeng, Lien ChingYi, & Liao, 2013) . Specifically, sugar levels as high as 8.41% were noted in cultivars like CYY95-26, whereas lower concentrations were in the region of 4.5% in cultivars like TNG73 (Adu-Kwarteng et al., 2014; Lai YungChang et al., 2013). Additionally, research on cultivars of the staple-type that can be harvested within the period of 3 to 5 months (i.e., 90-150 days) by Adu-Kwarteng et al. (2014) reported total soluble sugar contents ranging between 4.10 and 10.82 g/100 g dry weight. This gives us a comfortable maximum of 6.34 percent in the range reported on commercial sweet potatoes. The conversion of starch to sugars becomes more successful during late harvests, resulting in better sweetness and general quality characteristics. Sweetness is one of several sensory qualities that affect consumer preferences for sweet potatoes. Previous investigations have shown that consumers favored sweet, dry, and mealy sweet potato types, indicating the significance of sweetness in consumer preference (N'Zué et al., 2021; Nakitto et al., 2022) .

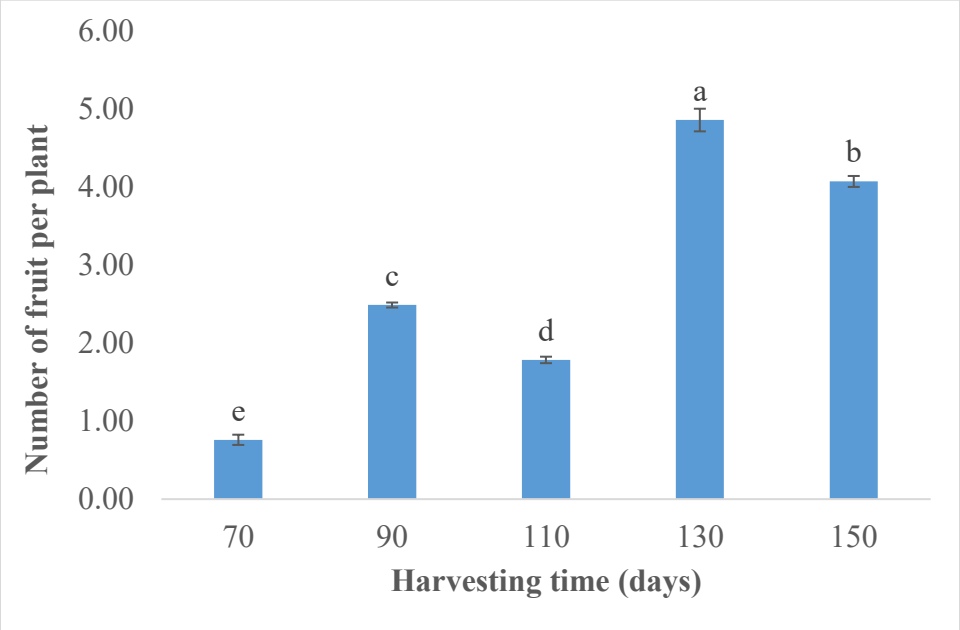

Figure 5: Average number of sweet potatoes tuberous roots per plant

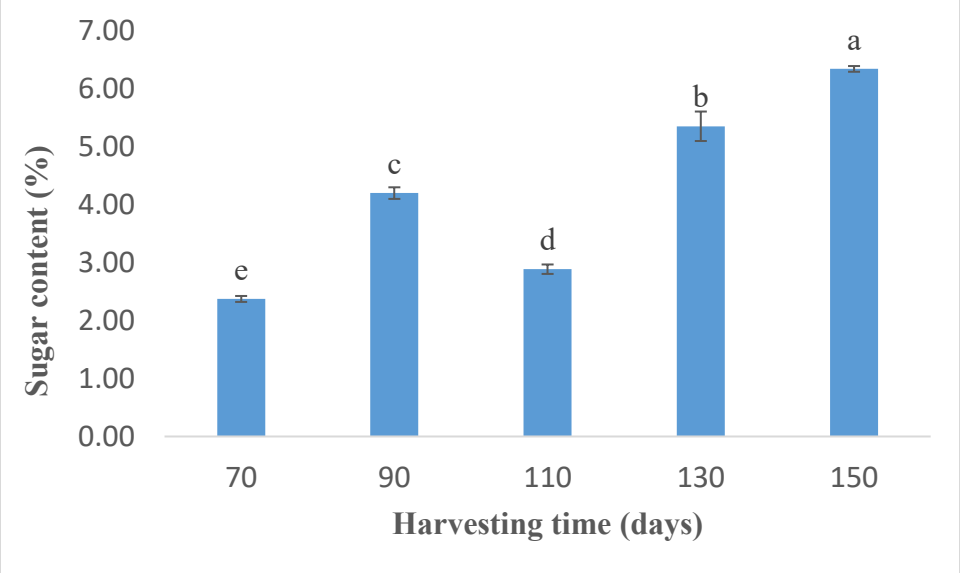

Figure 6: Average sugar content of sweet potatoes fruits (%)

4.Conclusions

This experiment found out that delayed harvest enhanced various yield and quality parameters, such as the weight of the tuber, their dimensions (tuber length and diameter), the presence of sugar, and general yield. As a rule, the period of harvesting beyond 150 days also turned out to be the most efficient in terms of yield and quality given the circumstances under the current study. The growth and harvest time of sweet potatoes are highly dependent on environmental conditions such as sunlight and temperature, which are critical for tuber development. Therefore, sweet potato cultivation during the winter season is not recommended.

Although the cultivar selected for this study was not a registered cultivar in Iraq or within the Kurdistan Region, it was imported from Turkey (Jewel Yams variety) and its performance in the

country in general was good. The results of the search are of practical interest to local farmers, and this leads to the conclusion that the sweet potatoes can potentially be grown in the region successfully by planting and harvesting at the right time.

Since the opportunity of sweet potatoes, a new crop in the Kurdistan Region exists, additional research can also be advised to study adaptability at other sites and how to design management practices applicable in the region such as fertilizer applications, planting dates and spacing. Besides, it is imperative to have varieties of sweet potatoes that are performing well registered and encouraged farmers to use more of them as well as enhance future production in the area.

Supplementary Materials:

There is a table with the means ± SE of measured parameters at different harvesting times for more transparency.

Author Contributions:

In this study, all authors contributed practically.

Funding:

All financial support from the beginning to the publishing of this research was funded by the JICA.

Institutional Review Board Statement:

The study was conducted following the protocol authorized by the JICA and MoAWR.

Informed Consent Statement:

No Informed Consent Statement.

Data Availability Statement:

The study was based on primary data collected from respondents.

Conflicts of Interest:

The authors declare that they have no conflict of interest.

Acknowledgments:

The authors acknowledge and highly appreciate the financial support from **JICA** through the **Sabat Project** ("Capacity Development Project for Agriculture Research and Extension" in KRI). In addition, the authors thank "The Directorate of Agriculture Training Center on Region-Erbil, Iraq" for providing the greenhouse. The authors also express gratitude to the anonymous reviewers for their comments and suggestions.

Disclaimer/Journal's Note:

The statements, opinions, and data in all publications are solely those of the individual author(s) and contributor(s), not AJAS and/or the editor(s). AJAS and/or the editor(s) disclaim responsibility for any injury to people or property resulting from ideas, methods, instructions, or products mentioned in the content.

References

Abd, D. A., Kareem, A. A., & Lahuf, A. A. (2021). Molecular identification of sweet potato whitefly Bemisia tabaci putative species in Karbala province, Iraq and possibility control it using the nanoparticles of MgO and ZnO. *Plant Cell Biotechnology and Molecular Biology, 22*(3-4), 175-184.

Adu-Kwarteng, E., Sakyi-Dawson, E. O., Ayernor, G. S., Truong, V.-D., Shih, F. F., & Daigle, K. (2014). Variability of sugars in staple-type sweet potato (Ipomoea batatas) cultivars: the effects of harvest time and storage. *International Journal of Food Properties, 17*(2), 410-420.

Almuoswi, H. J. N., & Al-bideri, A. W. (2019). Histological and immunohistochemical study of the healing role of the extract of Ipomoea batatas sweet potato extract in the gastric ulcer developed by aspirin in male albino rats. *EurAsian Journal of BioSciences, 13*(1), 399-407.

Belehu, T. (2005). *Agronomical and physiological factors affecting growth, development and yield of sweet potato in Ethiopia.* University of Pretoria,

Bhattarai, P., Tripathi, K., Shrestha, A., & Gautam, D. (2022). Effect of harvesting time on tuber yield and quality characters of sweet potato genotypes in Lalitpur and Chitwan, Nepal.

de Albuquerque, J. R. T., Ribeiro, R. M. P., Pereira, L. A. F., Junior, A. P. B., da Silveira, L. M., dos Santos, M. G., . . . Neto, F. B. (2016). Sweet potato cultivars grown and harvested at different times in semiarid Brazil. *African Journal of Agricultural Research, 11*(46), 4810-4818.

Etela, I., & Kalio, G. (2011). Yields components and 48-h rumen dry matter degradation of three sweet potato varieties in n'dama steers as influenced by date of harvesting. *Journal of Agriculture and Social Research (JASR), 11*(2), 15-21.

Gobena, T. L., Asemie, M. M., & Firisa, T. B. (2022). Evaluation of released sweet potato [Ipomoea batatas (L.) Lam] varieties for yield and yield-related attributes in Semen-Bench district of Bench-Sheko-Zone, South-Western Ethiopia. *Heliyon, 8*(10).

Hindersah, R., Karuniawan, A., & Apriliana, A. (2021). Reducing chemical fertilizer in sweet potato cultivation by using mixed biofertilizer. *Iraqi Journal of Agricultural Sciences, 52*(4).

Ishida, H., Suzuno, H., Sugiyama, N., Innami, S., Tadokoro, T., & Maekawa, A. (2000). Nutritive evaluation

on chemical components of leaves, stalks and stems of sweet potatoes (Ipomoea batatas poir). *Food chemistry, 68*(3), 359-367.

Jaleto, K. Influence of Harvest Stage on Yield and Yield Components of Orange Fleshed Sweet Potato [Ipomoea batatas (L) Lam] at Adami Tullu, Central Rift Valley of Ethiopia.

Kim, H. S., Lee, C.-J., Kim, S.-E., Ji, C. Y., Kim, S.-T., Kim, J.-S., . . . Kwak, S.-S. (2018). Current status on global sweetpotato cultivation and its prior tasks of mass production. *Journal of Plant Biotechnology, 45*(3), 190-195.

Lai YungChang, L. Y., Huang CheLun, H. C., Chan ChinFeng, C. C., Lien ChingYi, L. C., & Liao, W. (2013). Studies of sugar composition and starch morphology of baked sweet potatoes (Ipomoea batatas (L.) Lam).

Laurie, S., Van den Berg, A., Magoro, M., & Kgonyane, M. (2004). Breeding of sweetpotato and evaluation of imported cultivars in South Africa. *African Crop Science Journal, 12*(3), 189-196.

Lebot, V. (2019). *Tropical root and tuber crops*: Cabi.

Meng, X., Dong, T., Li, Z., & Zhu, M. (2024). First systematic review of the last 30 years of research on sweetpotato: elucidating the frontiers and hotspots. *Frontiers in Plant Science, 15*, 1428975.

Michael, P. S., & Peter, T. M. (2023). Sweet potato is a strategic root crop in Oceania: A synthesis of the past research and future direction. *SAINS TANAH-Journal of Soil Science and Agroclimatology, 20*(1), 51-65.

Motsa, N. M., Modi, A. T., & Mabhaudhi, T. (2015). Sweet potato (Ipomoea batatas L.) as a drought tolerant and food security crop. *South African Journal of Science, 111*(11-12), 1-8.

Mukhopadhyay, S. K., Chattopadhyay, A., Chakraborty, I., & Bhattacharya, I. (2011). Crops that feed the world 5. Sweetpotato. Sweetpotatoes for income and food security. *Food security, 3*(3), 283-305.

N'Zué, B., Essis, S. B., Ebah Djedji, C. B., Kouakou, M. A., Konan Dibi, B. E., Yah Koua, G. A., & Huges Kouassi, M. J. (2021). Consumer Preferences for Boiled and Fried Sweet Potato in Central and Northern Côte d'Ivoire, West Africa. *Journal of Advances in Biology & Biotechnology, 24*(8), 33-46.

Nakitto, M., Johanningsmeier, S. D., Moyo, M., Bugaud, C., de Kock, H., Dahdouh, L., . . . Ssali, R. T. (2022). Sensory guided selection criteria for breeding consumer-preferred sweetpotatoes in Uganda. *Food Quality and Preference, 101*, 104628.

Nations, F. a. A. O. o. t. U. (2023). The State of Food and Agriculture. Retrieved from http://www.fao.org/catalog/inter-e.htm

Nedunchezhiyan, M., Jata, S. K., & Byju, G. (2012). Sweet potato-based cropping systems. *Fruit, Veg. Cereal Sci. Biotech, 6*, 11-16.

Nunes, J. G. d. S., Leonel, M., Fernandes, A. M., Nunes, J. G. d. S., Figueiredo, R. T. d., Silva, J. A. d., & Menegucci, N. C. (2024). Yield and nutritional composition of sweet potatoes storage roots in response to cultivar, growing season and phosphate fertilization. *Ciência Rural, 55*(2), e20240046.

Sadiq, T., Takahata, M., Abdulla, A., Utagawa, H., Abdulmajid, K., Hasan, F., . . . Salih, K. (2025). EFFECT OF NANO, CONVENTIONAL NPK, ORGANIC FERTILIZERS AND PLANTING METHODS ON GROWTH AND YIELD CHARACTERISTICS OF MELON PLANTS (CUCUMIS MELO L.) UNDER GREENHOUSE CONDITIONS. *Anbar Journal of Agricultural Sciences, 23*(1).

Scott, G. J. (2021). A review of root, tuber and banana crops in developing countries: past, present and future. *International Journal of Food Science and Technology, 56*(3), 1093-1114.

Söğüt, T., & Öztürk, F. (2011). Effects of harvesting time on some yield and quality traits of different maturing potato cultivars. *African journal of biotechnology, 10*(38), 7349-7355.

Srisuwan, S., Sihachakr, D., & Siljak-Yakovlev, S. (2006). The origin and evolution of sweet potato (Ipomoea batatas Lam.) and its wild relatives through the cytogenetic approaches. *Plant Science, 171*(3), 424-433.

Tariq, F., Abdulrahman, C., & Rasheed, M. (2021). *Kinetics of phosphorus adsorption in the calcareous soils of Kurdistan region, Iraqi.* Paper presented at the IOP Conference Series: Earth and Environmental Science.

Team, M. o. A. a. W. R. J. I. C. A. E. (2023). *Capacity development project for agriculture research and extension: Baseline survey report of farmers' challenges and market demands in KRI*. Retrieved from https://drive.google.com/drive/folders/1y1KXC9uj9o9UXGk-VCL9vfO5KpozpOQw

Villordon, A., LaBonte, D., & Smith, T. (2013). Local nitrogen variability alters root architecture and influences storage root formation in the Beauregard sweet potato.

Villordon, A. Q., Ginzberg, I., & Firon, N. (2014). Root architecture and root and tuber crop productivity. *Trends in plant science, 19*(7), 419-425.

Woolfe, J. A. (1992). *Sweet potato: an untapped food resource*: Cambridge University Press.