



Research article

Phenological phases of two early-maturing sweetpotato (*Ipomoea batatas* [L.] Lam.) cultivars

Alfredo Morales^{1/*}, Dania Rodríguez²

¹Instituto de Investigaciones de Viandas Tropicales (INIVIT), Santo Domingo, Villa Clara, Cuba. 

²Instituto de Investigaciones de Viandas Tropicales (INIVIT), Santo Domingo, Villa Clara, Cuba. 

*Corresponding author. Email: alfremr88@gmail.com

DOI: <https://doi.org/10.15517/bjzt8996>

Received 28 Jan 2025; Accepted 24 April 2026

Abstract

Introduction. In Cuba, only general descriptions of sweetpotato phenology have been documented, without detailed information for producers and researchers. **Objective.** To characterize the main phenological phases of two early-maturing sweetpotato cultivars (*Ipomoea batatas* [L.] Lam.) under Cuban conditions. **Materials and methods.** A randomized complete block design with 10 replicates per cultivar was conducted at the Research Institute of Tropical Roots and Tuber Crops (INIVIT), Cuba. Two early cultivars from the INIVIT breeding program were evaluated: CEMSA 78-354 and INIVIT B-50. Evaluations were performed every seven days from 2 to 128 days after planting (DAP). **Results.** Plant tuberization initiation began at 28 DAP for both cultivars. In the final phase (100 - 128 DAP), CEMSA 78-354 increased yield by 14.18 t·ha⁻¹ and INIVIT B-50 by 11.84 t·ha⁻¹. From 86 DAP onward, Degrees Brix (°Bx) remained stable until harvest. The greatest increase in dry matter content occurred between 51 and 107 DAP: from 15.9% to 26.4% in CEMSA 78-354, and from 16.6% to 26.9% in INIVIT B-50. At 128 DAP, dry matter reached 28.15% (± 0.72) and 27.07% (± 1.11), respectively. **Conclusion.** In the second half of the cycle, CEMSA 78-354 allocated 63.1% (0.96 kg ± 0.13) of accumulated weight to tuberous roots, while INIVIT B-50 allocated 46.9% (1.08 kg ± 0.24). Three well-defined phenological phases are proposed for *Ipomoea batatas*: rooting (0-28 DAP), growth (29-65 DAP), and accumulation (66-128 DAP).

Keywords: Convolvulaceae; sugar accumulation; crop cycle; plant growth; root development.

Artículo científico

Resumen

Fases fenológicas de dos cultivares precoces de camote (*Ipomoea batatas* [L.] Lam.)

Introducción. En Cuba, solamente se tienen documentadas descripciones generales (sin información detallada) sobre la fenología del camote, un aspecto de interés para productores e investigadores. **Objetivo.** Caracterizar las principales fases fenológicas de dos cultivares precoces de camote (*Ipomoea batatas* [L.] Lam.) en condiciones cubanas. **Materiales y métodos.** Se utilizó un diseño de bloques completos al azar con 10 repeticiones por cultivar en el Instituto de Investigaciones de Viandas Tropicales (INIVIT), Cuba. Se evaluaron dos cultivares precoces del programa de mejora genética del INIVIT: CEMSA 78-354 e INIVIT B-50. Las evaluaciones se realizaron cada siete días desde los 2 hasta los 128 días después de la siembra (DDS). **Resultados.** El inicio de la tuberización ocurrió a los 28 DDS en ambos cultivares. En la fase final (100-128 DDS), el cultivar CEMSA 78-354 incrementó su rendimiento en 14,18 t·ha⁻¹ y el INIVIT B-50 en 11,84 t·ha⁻¹. A partir de los 86 DDS, los grados Brix (°Bx) se mantuvieron estables hasta la cosecha. El mayor incremento en el contenido de materia seca ocurrió entre los 51 y 107 DDS: del 15,9% al 26,4% en CEMSA 78-354, y del 16,6% al 26,9% en INIVIT B-50. A los 128 DDS, la materia seca alcanzó 28,15% ($\pm 0,72$) y 27,07% ($\pm 1,11$), respectivamente. **Conclusión.** En la segunda mitad del ciclo, CEMSA 78-354 destinó el 63,1% (0,96 kg $\pm$ 0,13) del peso acumulado a las raíces tuberosas, mientras que INIVIT B-50 destinó el 46,9% (1,08 kg $\pm$ 0,24). Se proponen tres fases fenológicas bien definidas para *Ipomoea batatas*: enraizamiento (0-28 DDP), crecimiento (29-65 DDP) y acumulación (66-128 DDP).

Palabras clave: Convolvulaceae; acumulación de azúcares; ciclo del cultivo; crecimiento de plantas; desarrollo de raíces.

Introduction

Sweetpotato (*Ipomoea batatas* [L.] Lam.) ranks among the world's most important food crops for human consumption. Currently, it holds 12th place in global food crop production, with an annual average of 93.5 million tons produced on 7.7 million hectares, making it the third most produced root and tuber crop after potato and cassava (FAOSTAT, 2021). Beyond production volume, its nutritional value (particularly vitamin A content among biofortified crops) surpasses most cereals. This crop is a typical food security crop because it can be harvested in a short cycle and provides carbohydrates, minerals, and β -carotene (pro-vitamin A) (Morales et al., 2024; Morales et al., 2025c). Furthermore, its ability to adapt to adverse climatic conditions, its effective response to meteorological phenomena, its versatility, and its vegetative reproduction place it above many other crops in terms of production potential (Lebot, 2010; CIP, 2019; Morales et al., 2025b).

Phenology aims to comprehensively study and describe the different developmental events that occur in plant species within natural or agricultural ecosystems, as well as their interaction with the environment. Knowing the timing of key developmental events such as rooting, vegetative growth, tuberization onset, and reserve accumulation allow producers to schedule irrigation, fertilization, pest control, and harvest more efficiently. Consequently, phenological phases are the basis for the implementation of any agricultural system, allowing producers to achieve greater efficiency in planning agricultural activities, which leads to increased crop productivity (Moreno & Romero, 2015; Liao et al., 2014).

The two early-maturing cultivars evaluated in this study come from the INIVIT genetic improvement program. On the one hand, CEMSA 78-354 has yellow skin and cream-colored flesh. It is characterized by high dry matter content and excellent stability under diverse growing conditions. Its texture and flavor make it suitable for both industrial processing and fresh consumption. On the other hand, INIVIT B-50 has red skin and yellow flesh. It is preferred for fresh consumption due to its good flavor and texture. Although neither cultivar shows strong resistance to sweetpotato weevil (*Cylas formicarius* Fab.), they are widely cultivated in Cuba due to their high yield potential, stable performance across seasons, and acceptable organoleptic qualities. Both cultivars are classified as early-maturing (cycle less than 130 days), a strategic trait for food security in Cuba, allowing rapid harvest cycles and reducing vulnerability to extreme weather events.

In order to achieve adequate management that allows greater agricultural production, aspects related to growth and dry matter accumulation in sweetpotato have been previously studied due to the global importance of this species (Somda et al., 1991; Morales & Maza, 2001; Marti, 2018). Previous studies on sweetpotato phenology have been conducted in other countries, but their results cannot be directly extrapolated to Cuban conditions due to differences in soil types, climate, and management practices. However, only general descriptions have been currently documented in Cuba, without detailed information on sweetpotato phenology, an aspect of great interest to both producers and researchers. Understanding the phenological behavior of early-maturing cultivars is particularly relevant because their short cycle may concentrate critical events in a narrower time window compared to late-maturing materials, with implications for nutrient uptake, water requirements, and susceptibility to pests and diseases.

Given the importance of this knowledge gap and the lack of information on *I. batatas* phenology in Cuba, this research aimed to characterize the main phenological phases of the two most important early-maturing cultivars in Cuban agriculture: CEMSA 78-354 and INIVIT B-50. The results will enable better understanding of the plant and establish the approximate timing of its phenological phases, facilitating the application of more efficient cultivation strategies and providing Cuban farmers and technicians with evidence-based criteria for improving crop management and harvest planning.

Materials and methods

Study area

Present research was conducted at the Research Institute of Tropical Roots and Tuber Crops (INIVIT), located in Santo Domingo municipality, Villa Clara province, Cuba (22°35'00" N, 80°14'18" W) at 50 m a.s.l. The trial was conducted under field conditions from January to June 2023. The soil was classified as a Inceptisol (Soil Survey Staff, 1999), with a sandy loam texture, pH of 7.2, and organic matter content of 2.1%.

Meteorological data were recorded by the automatic weather station managed by INIVIT (national meteorological network code: 78326). During the experimental period (January–June 2023), the average temperature was 24.8 °C, total accumulated rainfall was 412 mm, and average solar radiation was 18.2 MJ·m⁻²·day⁻¹.

Experimental design

A randomized complete block design (RCBD) with 10 replicates per cultivar was used. Two early-maturing sweetpotato cultivars from the INIVIT breeding program were evaluated: CEMSA 78-354 and INIVIT B-50. Each experimental unit consisted of eight furrows, each 7 m long, with a planting distance of 0.90 m between furrows and 0.25 m between plants, resulting in a usable area of 50.4 m² per plot. Each plot contained 232 plants, of which 162 central plants were evaluated, discarding border rows to avoid edge effects. Flood irrigation was applied every ten days, with a partial net norm of 250 m³·ha⁻¹. All other agronomic practices followed the technical recommendations for sweetpotato cultivation proposed by INIVIT (2012).

Variables

All morpho-physiological and agronomic variables were measured according to Morales et al. (2025a). The following six morpho-physiological characters were evaluated:

1. Leaf area per plant (dm²) (using the disc method) (leaves from internode 6 to 12 were used).
2. Main stem length (cm).
3. Number of stems per plant (considered stems, those greater than 30 cm).
4. Diameter of tuberous roots (cm) (in the center of stem).
5. Total Soluble Solids. They were determined as Brix degrees (°Bx) by using the Hanna digital refractometer (Hanna instruments, Woonsocket, R) with a range of 0 to 85% with a precision of 0.1 °Brix. Ten samples of tuberous roots were taken in each evaluation per cultivar and three readings were made on each sample.

6. Dry matter content (%). Five samples of approximately 100 g of fresh weight were taken from each cultivar. Each sample was fractioned into small parts and dried in an oven at 65 °C under atmospheric pressure for five days, at the end of which a constant weight was reached. The dry matter content (%) was estimated through the following equation with data aforementioned:

$$\% \text{ Dry matter} = \frac{\text{Dry weight}}{\text{Wet weight}} * 100 \text{ [equation 1]}$$

An agronomic evaluation was carried out on four characters:

1. Foliage yield (t ha⁻¹) (using the m² method) (two samples in each plot).
2. Weight of tuberous roots per plant (kg). A handheld digital dynamometer was used.
3. Yield of tuberous roots (t ha⁻¹).
4. Harvest index (%). It was calculated by dividing the fresh weight of the tuberous roots by the total biomass.

A total of 19 evaluations were conducted for all the variables under study, starting 2 days after planting (DAP) until 128 DAP, with an interval of seven days. In all evaluations, 10 plants per cultivar were harvested.

Management and statistical processing of data

All data were tabulated and organized in Microsoft Excel. Means and standard errors were calculated for descriptive analysis. Data normality was tested using the Shapiro-Wilk test, and homoscedasticity (homogeneity of variances) was tested using Levene's test. A two-way analysis of variance (ANOVA) was performed with cultivar and evaluation time as factors. When significant statistical differences were found ($p < 0.05$), means were separated using Tukey's HSD test. All statistical analyses were conducted using RStudio software (R programming language) (R Core Team, 2023).

Results and discussion

The analysis of leaf area per plant revealed significant statistical differences ($p < 0.05$) between the means of the cultivar itself in each evaluation. Leaf area showed slow growth during the first 65 days after planting (DAP). After this period, the plant began accelerating growth of this character. Maximum leaf area values were recorded in both cultivars between 86 and 107 DAP. INIVIT B-50 reached values of 188.85 dm², while CEMSA 78-354 reached 133.91 dm². At 128 DAP, INIVIT B-50 decreased its leaf area by 27.5% and CEMSA 78-354 by 25.3% (**Figure 1A**).

Stem length presented higher growth speed in the second half of the cycle (after 65 DAP), with values of 0.92 cm day⁻¹ in INIVIT B-50 and 0.74 cm day⁻¹ in CEMSA 78-354. Maximum stem length was reached in the last measurement (128 dap), with values of 116.7 cm in INIVIT B-50 and 96.3 cm in CEMSA 78-354 (**Figure 1B**).

The number of stems per plant remained stable in CEMSA 78-354 from 44 dap, with average values of 9.0 (± 1.61). In contrast, INIVIT B-50 stabilized after 79 DAP, with an average value of 19.0 (± 1.86) (**Figure 1C**).

The highest foliage yield in CEMSA 78-354 occurred between 93 and 121 DAP, with statistical differences compared to other evaluation moments. The average value in this period was 22.8 t ha⁻¹ (± 5.95). In INIVIT B-50, the highest foliage yield was recorded between 86 and 128 DAP, with significant statistical differences compared to other evaluation moments, reaching an average value of 50.4 t ha⁻¹ (± 9.74) (**Figure 1D**).

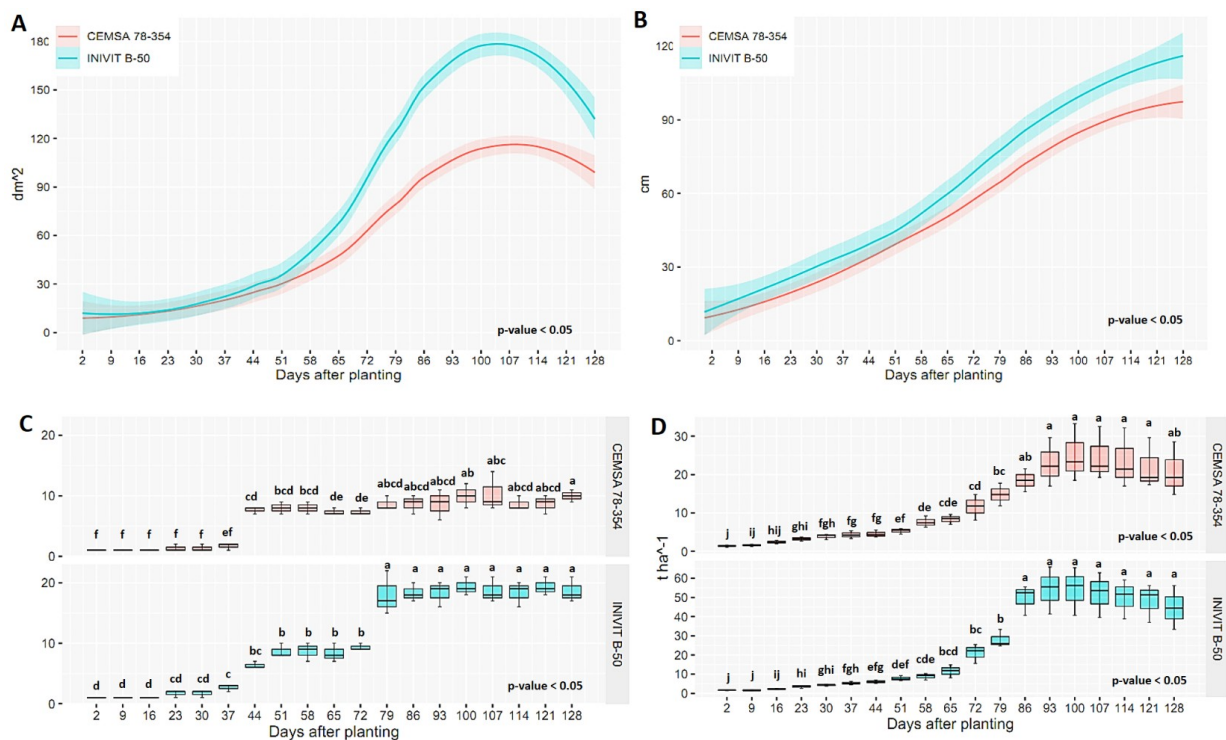


Figure 1. Leaf area per plant (A) and stem length (B) as line charts with error envelopes ($\pm$ SE); number of stems per plant (C) and foliage yield (D) as boxplots (median, IQR, min-max) for two sweetpotato cultivars (CEMSA 78-354 and INIVIT B-50). Different letters denote significant differences according to Tukey's HSD test ($p < 0.05$).

Figura 1. Área foliar por planta (A) y longitud del tallo principal (B) como gráficos de líneas con bandas de error ($\pm$ EE); número de tallos por planta (C) y rendimiento de follaje (D) como diagramas de caja (mediana, RIQ, mín-máx) para dos cultivares de camote (CEMSA 78-354 e INIVIT B-50). Letras distintas denotan diferencias significativas de acuerdo con la prueba HSD de Tukey ($p < 0,05$).

The results are similar to those obtained by Rodríguez et al. (2017), who stated that in sweetpotato the maximum leaf area is reached between 80 and 100 DAP depending on the vegetative cycle of the cultivar. The values obtained by the authors range between 85.5 and 291.2 dm² plant⁻¹. Somda et al. (1991) and Martí (2018) reported that stem length can vary from 1 to 6 m and the total number of stems per plant varies between 3 and 20 among cultivars.

The beginning of tuberization in both cultivars occurred at 28 DAP. Until 44 DAP, tuberous roots measured less than 1 cm in diameter. From this moment on, an accelerated process of thickening and reserve accumulation began. Tuberous roots of both cultivars showed an average growth of 0.9 mm day⁻¹. The maximum average diameter was recorded at 128 DAP, with 8.17 cm ($\pm$ 0.3) in CEMSA 78-354 and 8.93 cm ($\pm$ 1.92) in INIVIT B-50 (**Figure 2A**).

The analysis of tuberous root yield revealed significant statistical differences ($p < 0.05$) between the means of the cultivar itself in each evaluation. At 100 DAP, yield of CEMSA 78-354 was 21.34 t ha⁻¹ ($\pm$ 5.54), while yield of INIVIT B-50 was 28.34 t ha⁻¹ ($\pm$ 6.08). At 128 DAP, yield of CEMSA 78-354 reached 35.52 t ha⁻¹ ($\pm$ 4.97), without significant statistical differences with the yield at 121 DAP. Yield of INIVIT B-50 at 128 DAP was 40.08 t ha⁻¹ ($\pm$ 9.09), without significant statistical differences with yields at 114 and 121 DAP.

When comparing yield between 100 and 128 DAP, CEMSA 78-354 increased by 14.18 t ha⁻¹ (39.92% of total yield), while INIVIT B-50 increased by 11.84 t ha⁻¹ (29.54% of total yield). Before 65 DAP, the increase in tuberous root yield was not significant, but increased considerably after this moment, indicating that after 65 DAP the plant begins to translocate photoassimilates to tuberous roots to a greater extent (**Figure 2B**). At 128 DAP, harvest index in CEMSA 78-354 had an average value of 63.6%, while in INIVIT B-50 it reached 47.5% (**Figure 2C**).

The present results are consistent with those reported by Martí (2018), who reported that the onset of tuberization depends on interacting environmental and genetic factors that ultimately define crop yield. Tuber initiation is highly variable and generally cultivar-dependent, occurring between one and thirteen weeks after transplanting. Regarding the physiological mechanisms underlying tuber development, Dong et al. (2019) observed that auxin levels are high during the early stages of tuberous root formation but decrease as growth progresses. Mathura (2023) noted that this regulation of auxin concentration during storage organ development is crucial.

Morales & Rodríguez: Phenological phases of early sweet potato cultivars

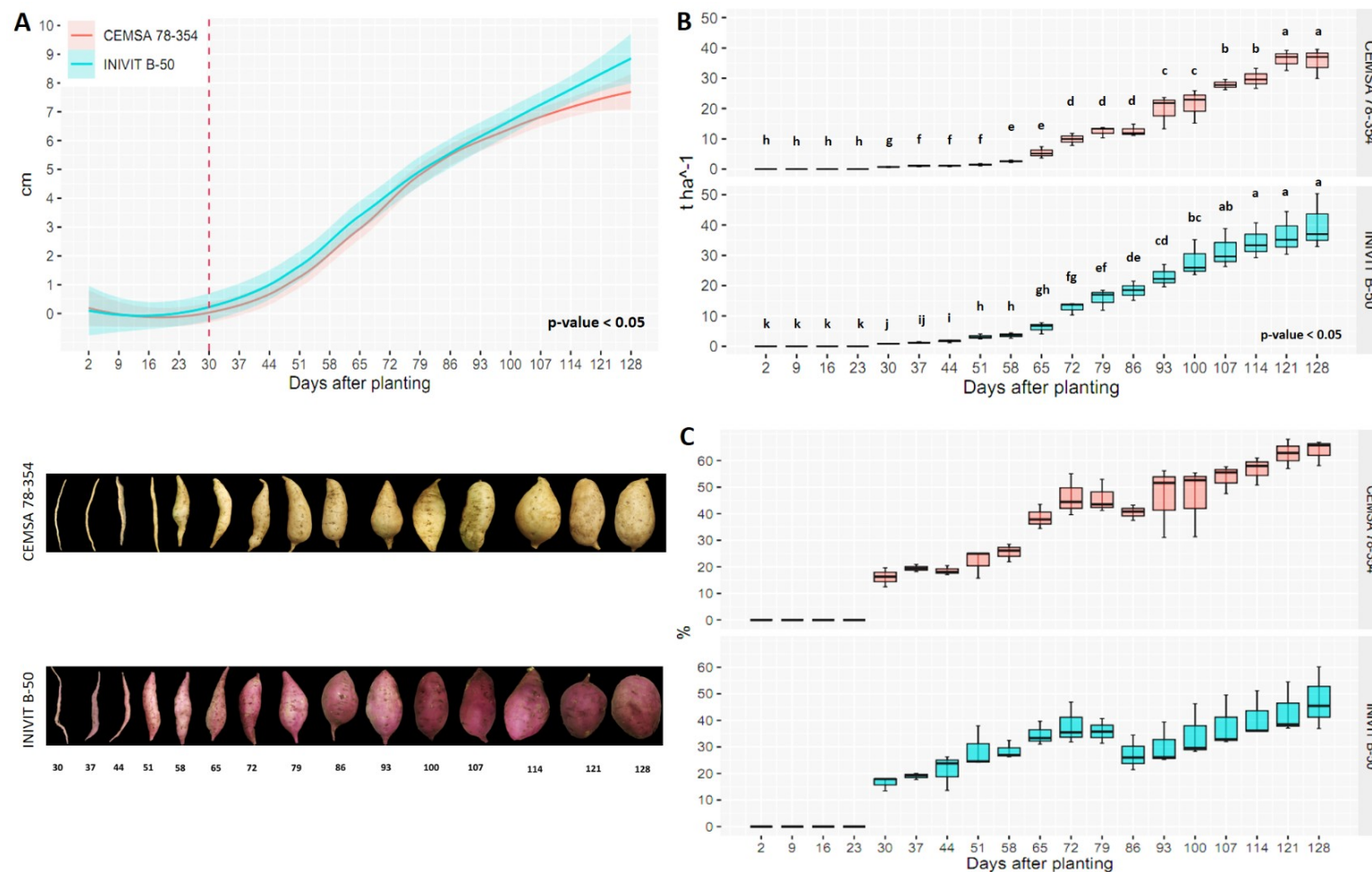


Figure 2. Diameter of tuberous roots (A) as line chart with error envelopes ($\pm$ SE); tuberous root yield (B) and harvest index (C) as boxplots (median, IQR, min–max) for two sweetpotato cultivars (CEMSA 78-354 and INIVIT B-50). Different letters denote significant differences according to Tukey's HSD test ($p < 0.05$).

Figura 2. Diámetro de las raíces tuberosas (A) como gráfico de líneas con bandas de error ($\pm$ EE); rendimiento de raíces tuberosas (B) e índice de cosecha (C) como diagramas de caja (mediana, RIQ, mín–máx) para dos cultivares de camote (CEMSA 78-354 and INIVIT B-50). Letras distintas denotan diferencias significativas de acuerdo con la prueba HSD de Tukey ($p < 0,05$).

Total soluble solids concentration expressed as Brix degrees ($^{\circ}\text{Bx}$) from 51 to 72 DAP was relatively low in both cultivars: $5.28 (\pm 0.65) ^{\circ}\text{Bx}$ in CEMSA 78-354 and $5.37 (\pm 0.72) ^{\circ}\text{Bx}$ in INIVIT B-50. After 86 DAP, $^{\circ}\text{Bx}$ concentrations showed relative stability until harvest (128 DAP), reaching average values of $8.87 (\pm 0.61) ^{\circ}\text{Bx}$ in CEMSA 78-354 and $8.83 (\pm 0.58) ^{\circ}\text{Bx}$ in INIVIT B-50 (**Figure 3A**).

From 51 to 107 DAP, a considerable increase in dry matter content occurred in both cultivars. In CEMSA 78-354, dry matter increased from 15.9% to 26.4% (10.5 percentage points increase, 0.66 times more). In INIVIT B-50, it increased from 16.6% to 26.9% (10.3 percentage points increase, 0.62 times more). From 107 to 128 DAP, the percentage increase in dry matter was 1.72% in CEMSA 78-354 and 0.17% in INIVIT B-50, indicating that after 107 DAP the percentage increase in dry matter is not high. At 128 DAP, CEMSA 78-354 had a dry matter of 28.15% (± 0.72) and INIVIT B-50 had 27.07% (± 1.11) (**Figure 3B**).

Analysis of foliage and tuberous root growth revealed a marked difference before (first half of the cycle) and after (second half of the cycle) 65 DAP. CEMSA 78-354 accumulated 15.1% of its total fresh weight in the first half of the cycle and 84.9% in the second half. INIVIT B-50 accumulated 21.7% in the first half and 78.3% in the second half.

Regarding the weight accumulated in the second half of the cycle, CEMSA 78-354 allocated 63.1% ($0.96 \text{ kg} \pm 0.13$) to tuberous roots, while INIVIT B-50 allocated 46.9% ($1.08 \text{ kg} \pm 0.24$) to tuberous roots (**Figure 4 and 5**). Two different growth patterns were observed: CEMSA 78-354 (at the end of its cycle) showed greater tuberous root weight than foliage weight, while the opposite pattern was observed in INIVIT B-50. However, both cultivars showed a tendency to decrease foliage weight while tuberous root weight increased constantly (**Figure 3C and D**).

The harvest index (HI) difference between cultivars (63.6% in CEMSA 78-354 vs. 47.5% in INIVIT B-50) can be explained by genetic differences in source-sink relationships. Rodríguez et al. (2017) demonstrated that sweetpotato yield is controlled by non-additive genetic effects, mainly heterosis. Our results suggest that CEMSA 78-354 possesses a genetic constitution favoring stronger sink activity, attracting more photoassimilates to tuberous roots. Morales (2018) noted that a higher HI results from greater distribution of photoassimilates from foliage to roots, which we confirmed: CEMSA 78-354 allocated 63.1% of second-half accumulated weight to tuberous roots, while INIVIT B-50 allocated only 46.9%.

The dry matter values we obtained (28.15% and 27.07%) fall within the range reported by Morales (2018) for sweetpotato (18.33-38.97%, average 26.2%). Similarly, our $^{\circ}\text{Bx}$ values at harvest (8.83-8.87) are within the ranges reported by Morales (2018) (7.80-15.37, average 10.91) and Rodríguez del Sol et al. (2022) (8.30-15.05 at 90 DAP; 7.13-11.66 at 150 DAP), though at the lower end. This is characteristic of early-maturing cultivars, which prioritize rapid cycle completion over maximum sugar accumulation.

Morales & Rodríguez: Phenological phases of early sweet potato cultivars

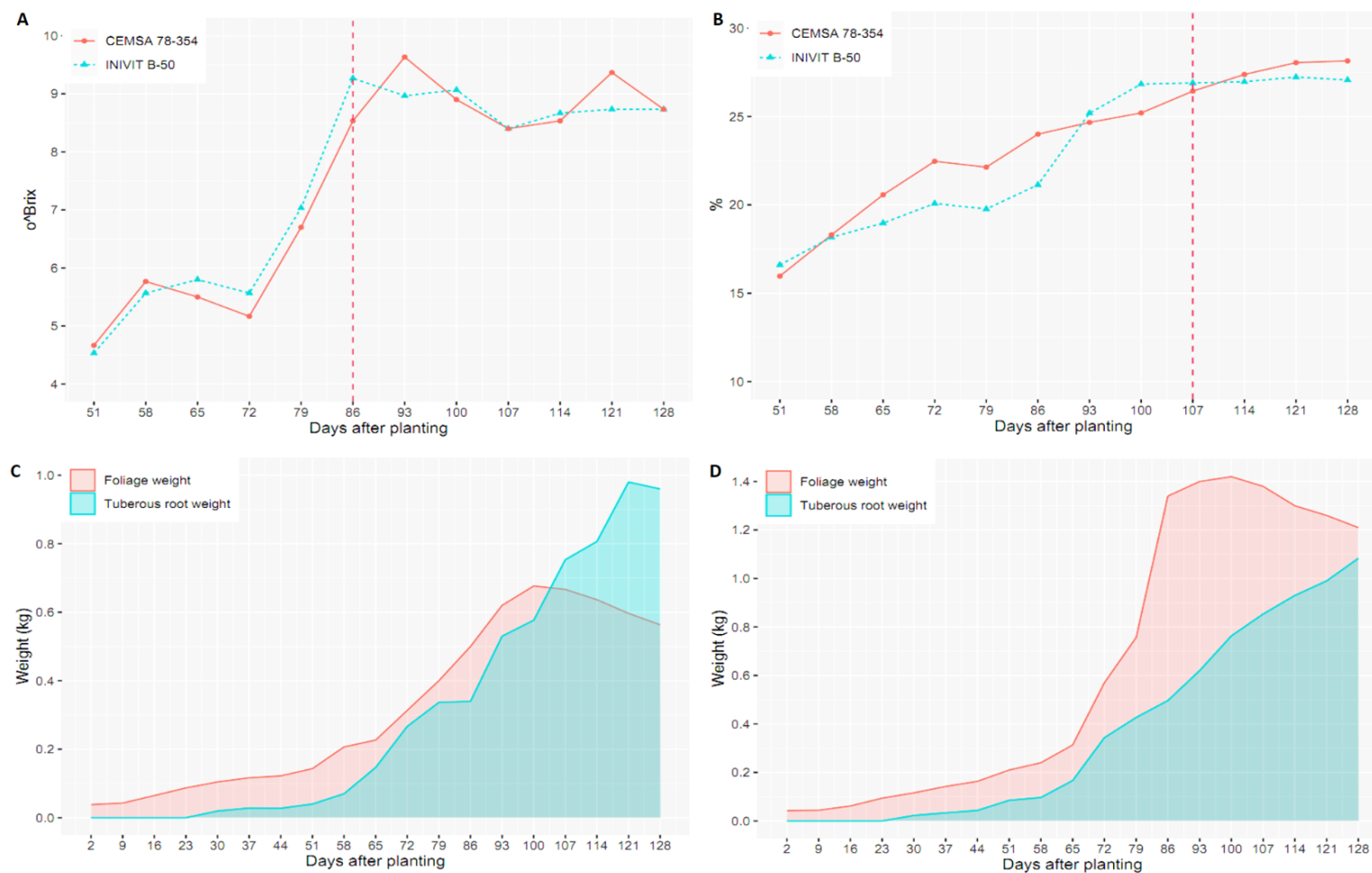


Figure 3. Total soluble solids (A), Dry matter content (B), Fresh weight of foliage and tuberous roots per plant of two sweetpotato cultivars: CEMSA 78-354 (C) and INIVIT B-50 (D).

Figura 3. Sólidos solubles totales (A), Contenido de materia seca (B), Peso fresco del follaje y de las raíces tuberosas por planta de dos cultivares de camote: CEMSA 78-354 (C) e INIVIT B-50 (D).

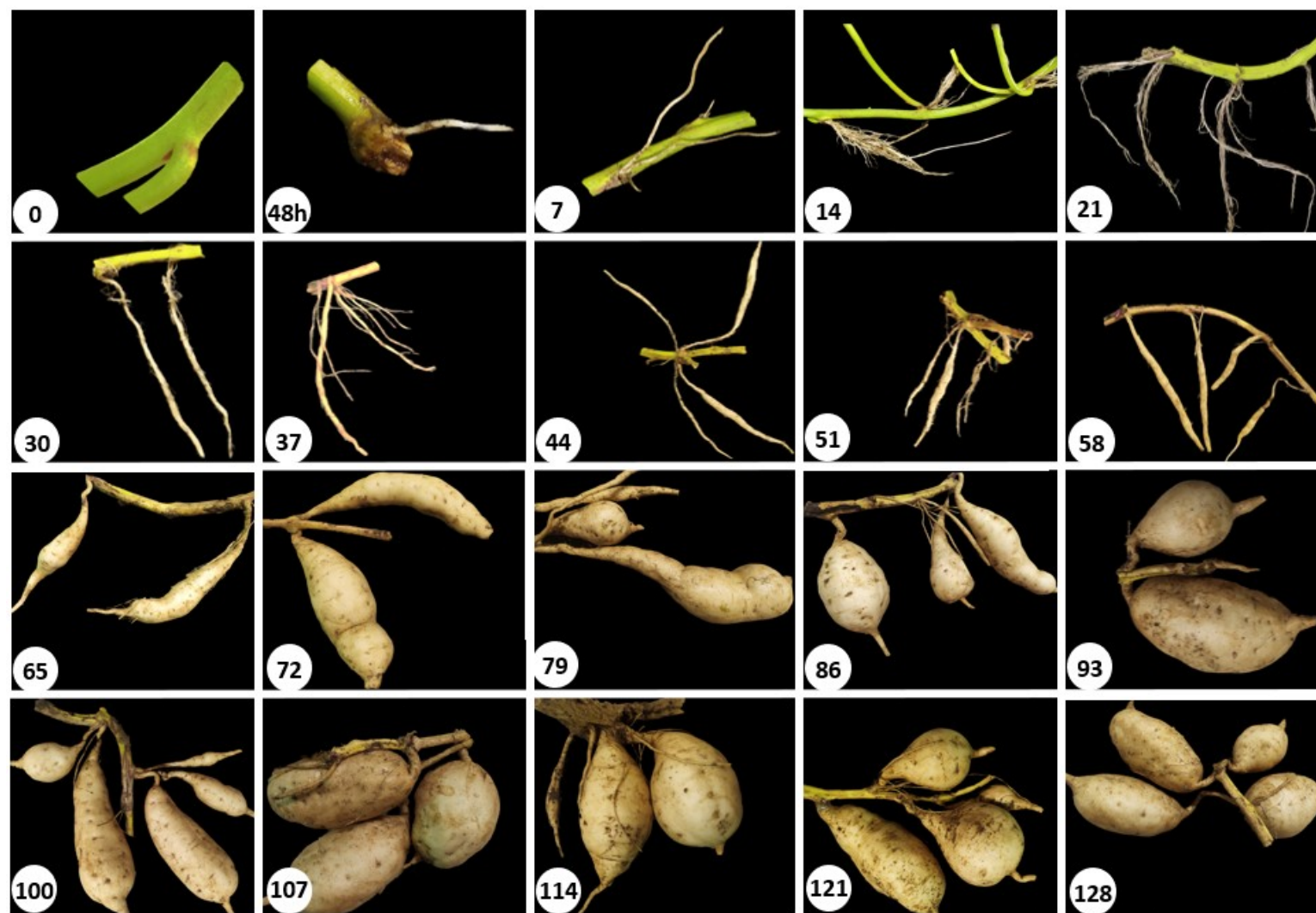


Figure 4. Development and growth of tuberous roots of sweetpotato, cultivar CEMSA 78-354.

Figura 4. Desarrollo y crecimiento de las raíces tuberosas de camote, cultivar CEMSA 78-354.

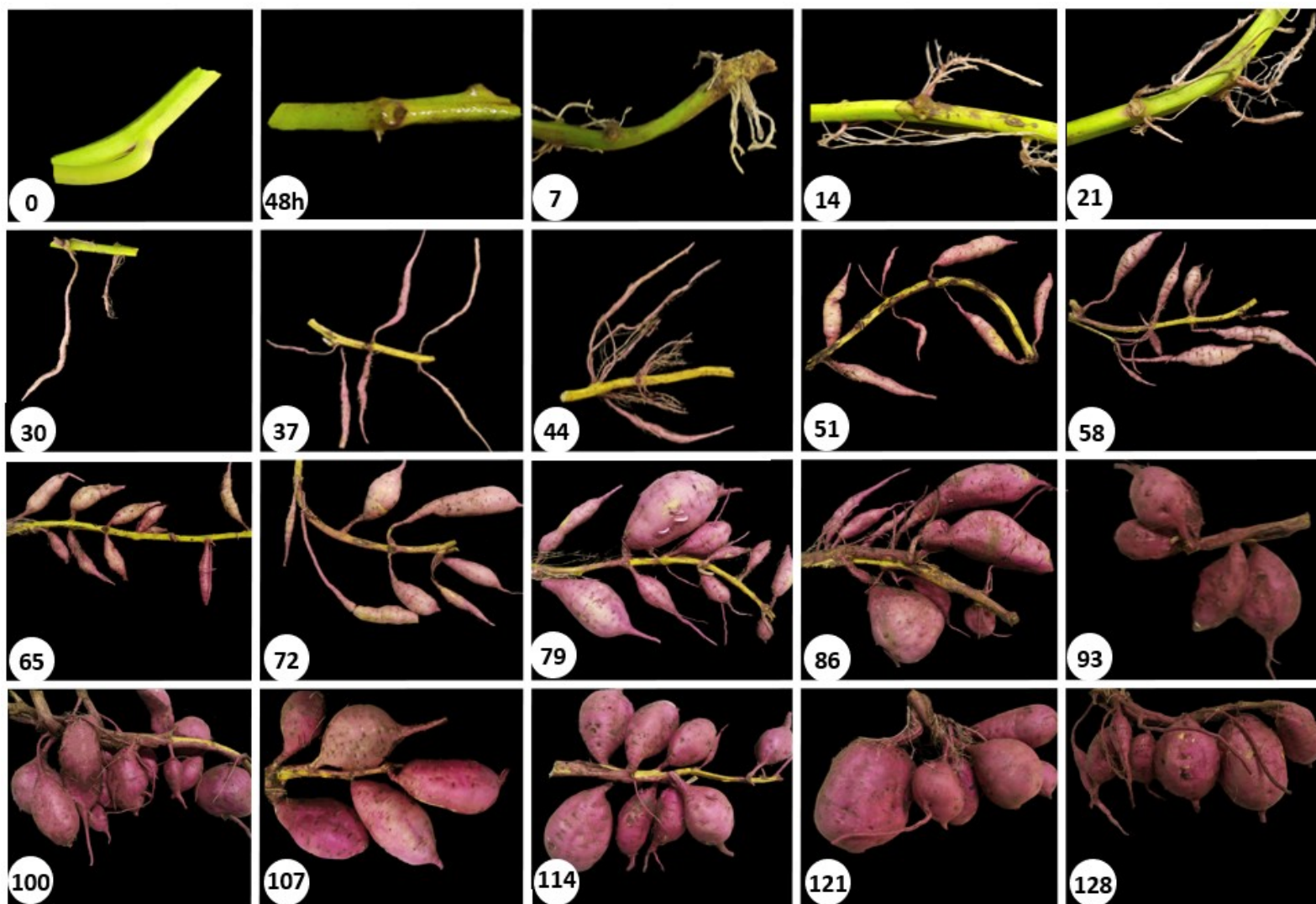


Figure 5. Development and growth of tuberous roots of sweetpotato, cultivar INIVIT B-50.

Figura 5. Desarrollo y crecimiento de las raíces tuberosas de camote, cultivar INIVIT B-50.

Martí (2018) reported that sweetpotato accumulates about 25% of final weight in the first half of the cycle, with proportions reversing in the second half. Our early cultivars showed slightly lower first-half accumulation (15-22%), likely because they initiate the shift to tuber filling sooner. Dong et al. (2019) observed that auxin levels are high during early tuberous root formation but decrease as growth progresses, while Mathura (2023) noted that auxin regulation during storage organ development is crucial. This explains our °Brix pattern: low during early structural development (51-72 DAP), then stabilizing after 86 DAP when roots shift to storage mode.

In this regard, Jaleto (2023) found that stem growth is slow in the first 30 DAP, with fresh biomass increasing between 90-120 DAP and decreasing thereafter due to senescence. Our leaf area data support this, with decreases of 25-27% after 107-128 DAP. The fact that both cultivars showed decreasing foliage weight while tuberous root weight increased constantly confirms the senescence-driven translocation model.

The tuberous root weights we obtained (0.96-1.08 kg per plant) fall within the ranges reported by Morales (2018) (45.3-1330.7 g) and Burbano et al. (2020) (0-1874.33 g), indicating good performance for early-maturing cultivars under our conditions.

Considering all the results, three well-defined phenological phases are proposed for early-maturing sweetpotato cultivars (**Figure 6**):

Phase I. Rooting (0-30 DAP). This phase extends from planting until the beginning of tuberization. Plant growth is mainly dedicated to the emission and growth of fibrous roots and pencil roots, with limited foliage growth. This is a critical stage where the total number of tuberous roots that each plant will produce is defined.

Phase II. Growth (30-100 DAP). This phase begins with tuberization onset. It is the stage of greatest growth of both foliage and tuberous roots. Accelerated leaf area growth occurs until reaching maximum values, along with increased foliage yield, greater stem length growth, and high emission of secondary stems. Regarding tuberous root growth, this stage shows the greatest increase in diameter, yield, as well as dry matter and total soluble solids accumulation.

Phase III. Accumulation (100 DAP to harvest, 128 DAP). At this stage, leaf area decreases, stem length shows little increase, and no emission of secondary stems or foliage yield increase occurs. Growth is dedicated exclusively to tuberous roots (size and weight), although the percentage increase in dry matter content is low. Between 30-40% of total tuberous root yield is accumulated during this phase, indicating that it is an exclusive phase for photoassimilate accumulation in tuberous roots.

The optimal harvest window for maximizing dry matter is between 107 and 128 DAP, as gains after this point are negligible. Cultivar-specific recommendations: CEMSA 78-354 is superior for high-yield, high-dry-matter production (processing industry), while INIVIT B-50 is suitable for fresh consumption and dual-purpose systems.

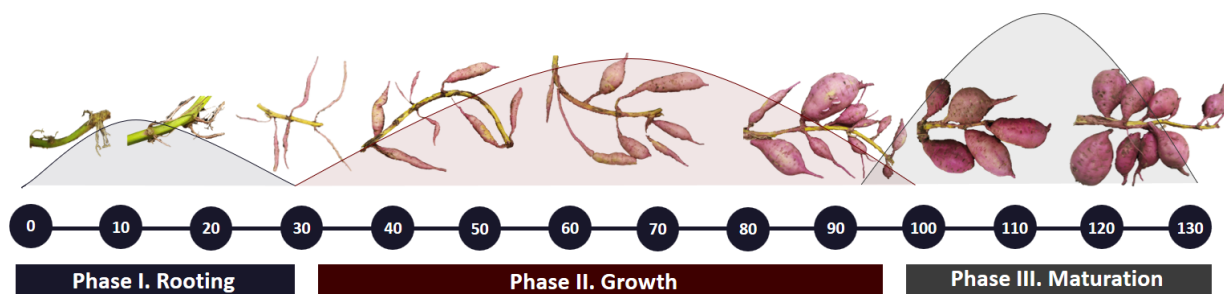


Figure 6. Phenological phases of sweetpotato (Rooting, Growth, Accumulation) proposed in present study.

Figura 6. Fases fenológicas del camote (Enraizamiento, Crecimiento, Acumulación) propuestas en el presente estudio.

Conclusions

The foliage growth of sweetpotato plants (leaf area, stem length, number of stems, and foliage yield) is slow until 40-60 days after planting, after which accelerated growth occurs, while tuberous root growth begins at 28 days and shows its greatest increase after 50 days until harvest. The highest increase in dry matter content occurs between 51 and 107 days after planting, with minimal gain after this period. Of the weight accumulated in the second half of the cycle, CEMSA 78-354 allocates 63.1% ($0.96 \text{ kg} \pm 0.13$) to tuberous roots, whereas INIVIT B-50 allocates only 46.9% ($1.08 \text{ kg} \pm 0.24$), reflecting fundamental differences in carbon allocation efficiency between the two cultivars. Based on these results, three well-defined phenological phases are proposed for early-maturing sweetpotato cultivars under Cuban conditions: Rooting (0-30 days after planting), Growth (30-100 days after planting), and Accumulation (100 days after planting to harvest), providing a practical framework for improved crop management and harvest planning.

Literature cited

- Burbano, E., Cordero, C., Pastrana, I., Espitia, L., Gomez, E., Morales, A., & Rosero, A. (2020). Interrelation of ecophysiological and morpho-agronomic parameters in low altitude evaluation of selected ecotypes of sweetpotato (*Ipomoea batatas* [L.] Lam.). *Horticulturae*, 6(4), 1-22.
- Centro Internacional de la Papa (CIP). (2019). Cyclone Idai: Jump-starting farmer recovery in Mozambique.
- Dong, T., Zhu, M., Yu, J., Han, R., Tang, C., Xu, T., Liu, J., & Li, Z. (2019). RNA-Seq and iTRAQ reveal multiple pathways involved in storage root formation and development in sweetpotato (*Ipomoea batatas* L.). *BMC Plant Biology*, 19(1), 1-16.

- FAOSTAT. (2021). FAOSTAT statistical database. <https://www.fao.org/statistics/es/>
- Jaleto, B. (2023). Review on influence of genotypes and harvest stage on yield and yield components of sweetpotato *Ipomoea batatas* (L.) Lam. *Global Journal of Agriculture and Agricultural Science*, 11(1), 1-4.
- Instituto de Investigaciones de Viandas Tropicales (INIVIT). (2012). *Instructivo técnico del cultivo del boniato*. (2da. ed.). Asociación Cubana de Técnicos Agrícolas y Forestales.
- Lebot, V. (2010). Root and Tuber Crops. Chapter 3, Sweetpotato. In J. E. Bradshaw (Ed.), *Handbook of Plant Breeding*. Springer Science Business Media.
- Liao, J., Zhou, H., Zhang, H., Zhong, P., & Huang, Y. (2014). Comparative proteomic analysis of differentially expressed proteins in the early milky stage of rice grains during high temperature stress. *Journal of Experimental Botany*, 65(2), 655-671.
- Martí, H. (2018). *Producción de batata* (1ra ed.). Ediciones INTA. Buenos Aires, Argentina.
- Mathura, S. (2023). Deciphering the hormone regulatory mechanisms of storage root initiation in sweetpotato: Challenges and future prospects. *AoB Plants*, 15(3), 1-8.
- Morales, A. (2018). Caracterización morfo-agronómica de la colección de batata (*Ipomoea batatas* (L.) Lam.) de CORPOICA, Colombia, [Tesis de Maestría, Universidad Central "Marta Abreu" de Las Villas]. 89 p.
- Morales, A., & Maza, N. (2001). Aspectos generales sobre el cultivo de camote (Boniato) en Cuba. In F. Cisneros & J. Alcazar (Eds.), *Manejo integrado del gorgojo del camote o tetuán del boniato, Cylas formicarius* (Fab.), en Cuba. Centro Internacional de la Papa (CIP).
- Morales, A., Vargas, I., Rodríguez, D., Portal, O., García, Y., García, Y., Medina, A., Valdivies, Y., & Chávez, V. (2024). Inheritance of the flesh color and shape of the tuberous root of sweetpotato (*Ipomoea batatas* [L.] Lam.). *Horticulturae* 10, 1032.
- Morales, A., Ma, P., Jia, Z., Rodríguez, D., Pastrana, I. J., Ventura, V., González, J. E., Portal, O., Díaz, F., Álvarez, O., Cordero, C., & Bian, X. (2025a). Evolution of sweetpotato (*Ipomoea batatas* [L.] Lam.) breeding in Cuba. *Plants*, 14(13), 1911.
- Morales, A., Ma, P., Jia, Z., Rodríguez, D., Pastrana, I. J., González, R. E., Molina, O., Jiménez, A., Rodríguez, Y., Morales, L., Beovides, Y., Portal, O., & Bian, X. (2025b). Decoding phenotypic signatures of *Cylas formicarius* Fab. resistance in a global sweetpotato (*Ipomoea batatas* [L.] Lam.) germplasm collection. *Frontiers in Plant Science*, 16, 1504567.

- Morales, A., Pastrana-Vargas, I. J., Rodríguez, D., Jia, Z., Ma, P., & Bian, X. (2025c). Sweetpotato (*Ipomoea batatas* [L.] Lam.) breeding: From reproductive biology to variety development. In K. P. Waidyarathne (Ed.), *Root vegetables - scientific research and practical application*. IntechOpen.
- Moreno, L. P., & Romero, H. M. (2015). Phenology of the reproductive development of *Elaeis oleifera* (Kunth) Cortes. *Agronomía Colombiana*, 33(1), 36-42.
- Rodríguez del Sol, D., Morales Rodríguez, A., Rodríguez Morales, S. J., Rodríguez García, Y., Jiménez Medina, A., & Trujillo Oviedo, N. (2022). Sólidos solubles totales de 10 cultivares mejorados de boniato (*Ipomoea batatas* [L.] Lam.). *Revista Agricultura Tropical*, 8(1), 54-58.
- Rodríguez, D., Morales, A., Morales, A., Herrera, A., & Díaz, A. (2017). Evaluación morfo-agronómica y fisiológica de seis genotipos mejorados de boniato (*Ipomoea batatas* (L.) Lam.). *Revista Agricultura Tropical*, 3(1), 20-30.
- R Core Team. (2023). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. <https://www.R-project.org/>
- Soil Survey Staff. (1999). Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys (2nd ed.). Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.
- Somda, Z., Mohamed, M., & Kays, S. (1991). Analysis of leaf shedding and dry matter recycling in sweetpotato. *Journal of Plant Nutrition*, 14, 1201-1212.

