



EVALUATING THE EFFICACY OF CONTAINER TYPES AND SIZES FOR SWEET POTATO CONTAINER CULTIVATION FOR URBAN GARDENING

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ABSTRACT

The study was conducted at National Root Crops Research Institute (NRCRI), Iresi Sub-Station, Osun State during 2024 and 2025 rainy seasons to evaluate the effects of container type and soil volume on the vegetative growth and root yield of two sweet potato varieties. The treatments consisted of two (2) container types (bucket and sack), three (3) soil volumes (5, 10 and 15 L) and two (2) varieties of sweet potato (*Ex-Igbariam* and *Mothers Delight*), these were factorially combined and laid out in a randomized complete block design replicated three times. Data were collected on vine length, number of leaves, and number of branches at 6–14 weeks after planting. Others were marketable and unmarketable root yields assessed at harvest. Results indicated that, soil volume was the primary determinant of vegetative growth and marketable root yield, with larger containers consistently enhancing canopy development and yield. Container type had minimal influence when soil volume was held constant, and increased soil volume did not increase unmarketable yield. Varietal differences were observed in growth dynamics and yield response to soil volume, while treatment effects were generally stable across seasons. The study demonstrates that adequate soil volume, rather than container material, is critical for efficient sweet potato production in container-based systems. These results provide practical guidance for urban growers, supporting the use of low-cost containers combined with sufficient soil volume to optimize sweet potato productivity in space-limited environments.

Keywords: Container-based, Agriculture, Urban, Soil, Volume, Cultivation

INTRODUCTION

The accelerating pace of global population growth and urban expansion continues to exert immense pressure on existing agricultural systems and arable land resources. As arable land availability declines, the need for innovative, sustainable, and space-efficient food production systems becomes increasingly critical (van Dijk *et al.*, 2021). Urban agriculture, particularly container-based gardening, has emerged as a promising approach for ensuring food availability within city environments, offering advantages such as efficient use of limited space, recycling of materials, and proximity to consumers (Onwubiko, 2022). Among the various crops suited to container cultivation, sweet potato (*Ipomoea batatas* L. [Lam]) stands out due to its adaptability to diverse environmental conditions, relatively short growth cycle, and dual-purpose potential as both a root and leafy vegetable (Truong, 2018). Sweet potato has been recognized as a critical crop for enhancing urban food and nutritional security, given its high yield potential and nutrient-rich roots and foliage. However, despite its suitability, the optimal container configurations, in terms of container type and soil volume, necessary to maximize sweet potato productivity in restricted urban spaces remain poorly understood.

Thus, the objectives of the study were to evaluate the growth performance of two sweet potato varieties (*Ex-Igbariam* and *Mothers Delight*) cultivated under different container types (plastic buckets and sacks); assess the influence of varying container soil volumes (5 L, 10 L, and 15 L) on root yield, root quality, and vegetative growth parameters; and identify the most effective container configuration for maximizing productivity and resource efficiency in urban sweet potato cultivation.

MATERIALS AND METHODS

The two-year study was conducted during the 2024 and 2025 rainy seasons at the National Root Crops Research Institute (NRCRI), Iresi Sub-Station, Osun State, Nigeria (7°55'N, 4°49'E; 541 m a.s.l.), located in the derived savanna zone. The treatments consisted of two (2) container types (bucket and



sack), three (3) soil volumes (5, 10 and 15 L) and two (2) varieties of sweet potato (*Ex-Igbariam* and *Mothers Delight*), these were factorially combined to give twelve treatments and laid out in a randomized complete block design (RCBD) replicated three times. Sacks were reshaped to match bucket dimensions, the containers were perforated (1 cm) for drainage at the base and lower sides uniformly, and then filled with a 1:1 mixture of topsoil and sandy soil. Vine cuttings (20 cm, four nodes) were planted singly per container and the containers were raised on logged platform. Pots were irrigated with a liter of water each at 2 days interval and a single NPK (15:15:15) fertilizer application was made at 6 weeks after planting (WAP) at 200 kg ha⁻¹. Weeding was done manually every 3 weeks and growth data (vine length, number of branches, number of leaves, and lead area) were collected biweekly from 6–14 WAP, while yield parameters (number and fresh weight of marketable and unmarketable roots) were recorded at 16 WAP.

Data collected were analyzed using linear mixed-effects models in R (version 4.5.2). Year and blocks were nested within year treated as random effects while variety, container type, container size, and their interactions were fixed effects. Growth traits measured at 6–14 WAP were analyzed as repeated measures, with container as the subject. Marketable and unmarketable root yields were analyzed without repeated measures. Type III ANOVA was used, with degrees of freedom estimated using Satterthwaite or Kenward–Roger methods. Means were separated using Tukey-adjusted estimated marginal means at $P \leq 0.05$.

RESULTS AND DISCUSSION

This study evaluated the effects of container type and soil volume on the growth and yield of sweet potato varieties under urban container cultivation. The results showed that soil volume was the primary determinant of vegetative growth and marketable yield, while container type had minimal influence, and varietal differences were mainly expressed through growth dynamics and yield response to container size. These findings identify adequate soil volume and appropriate variety selection as the key factors for efficient sweet potato production in container-based urban systems.

Vine Length, Number of Leaves, and Number of Branches

Vegetative growth of sweet potato, expressed as vine length, number of leaves, and number of branches, was primarily influenced by weeks after planting (WAP) and container size (soil volume), whereas container type (bucket vs sack) had little or no effect on growth traits (Table 1; Figure 1). Growth increased progressively from 6 to 14 WAP across all treatments, with the most pronounced increases occurring after 10 WAP, reflecting normal developmental progression during canopy expansion. This pattern is consistent with Low *et al.* (2020), who noted that canopy development in orange-fleshed sweet potato responds positively to increased nutrient and rooting space availability, particularly during the bulking phase.

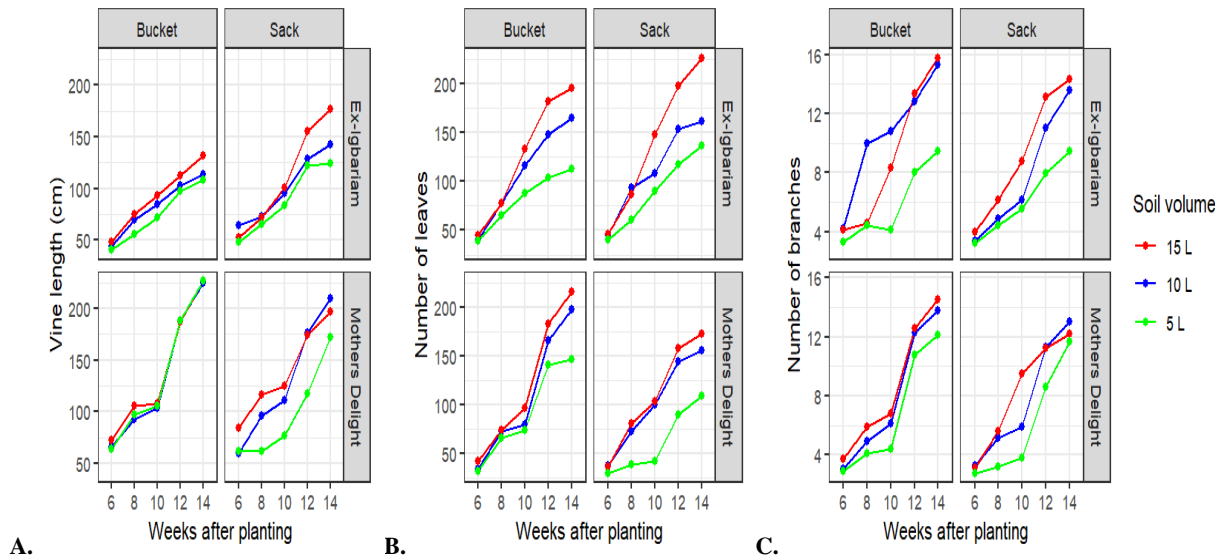


Figure 1: Temporal responses of (A.) vine length, (B.) number of leaves, and (C.) number of branches of sweetpotato varieties to container size and container type under container-based cultivation.

Vine length responded significantly to variety, container size, and WAP, with notable interactions involving variety and growth stage. *Mothers Delight* exhibited stronger vine elongation at later stages (10–14 WAP), particularly in larger containers, compared with *Ex-Igbariam*, indicating varietal differences in growth strategy (Figure 1). Similar varietal growth responses to space availability have been observed by Abdallah (2022) in drought-tolerant sweet potato clones and ornamental varieties in coastal Kenya. In contrast, container type did not significantly influence vine length, confirming that vine elongation was driven mainly by available soil volume rather than container material, as also supported by Ajisope (2023) in his comparative study of urban agriculture systems in Nigeria and the UK.

Table 1: Effects of Container Type, Variety and Soil Volume on Vine Length (cm) of Sweet Potato

Treatments	Weeks After Planting (WAP)				
	6	8	10	12	14
Container Type (CT)					
Bucket	49.2	86.0	104.0	149.0	174.0
Sack	55.7	82.3	105.0	148.0	173.0
LS	NS	NS	NS	NS	NS
SE±	4.85	3.74	3.80	4.02	2.98
Variety (V)					
Ex-Igbariam	44.6	70.1	95.5	128.0	141.2
Mothers Delight	60.4	98.3	113.3	170.0	207.0
LS	**	***	***	***	***
SE±	4.83	3.72	3.78	4.00	2.96
Soil Volume (SV)					
5 L	47.5	69.2	86.4	129.0	159.0
10 L	53.4	89.7	112.0	159.0	181.0
15 L	56.4	93.6	114.8	158.0	182.0
LS	NS	***	***	***	***
SE±	5.41	4.46	4.49	4.42	3.45
Year (Y)					
2024	35.4	93.5	130.6	161.0	186.0
2025	69.6	74.8	78.3	137.0	162.0
LS	**	*	***	*	**
SE±	4.86	3.90	4.10	4.94	3.34
Interaction					
CT x V	NS	NS	NS	***	***
CT x SV	NS	NS	*	***	***
CT x Y	NS	*	***	***	*
V x SV	NS	NS	NS	***	***
V x Y	NS	NS	NS	***	***
SV x Y	NS	*	**	***	***

LS = Level of significance; SE = Standard error; *** $P \leq 0.001$; ** $P \leq 0.01$; * $P \leq 0.05$; ns ($P > 0.05$)
 Leaf number and branch number were strongly affected by container size and WAP, with larger containers consistently supporting greater canopy development (Figure 1B and C). The lower leaf and branch numbers observed in 5 L containers highlight the restrictive effect of limited soil volume on vegetative growth (Tables 2 and 3). Varietal effects on these traits were generally small, although time-dependent interactions indicate that subtle differences in canopy development emerged as plants matured. This observation corresponds with the findings of Adubasim *et al.* (2017) and Paul *et al.* (2020), who reported that soil and organic matter improvements in small-scale horticulture substantially increase photosynthetic area and canopy efficiency in root crops.



Table 2: Effects of Container Type, Variety and Soil Volume on Number of Leaves of Sweet Potato

Treatments	Weeks After Planting (WAP)				
	6	8	10	12	14
Container Type (CT)					
Bucket	32.00	80.01	107.91	157.89	169.98
Sack	32.01	77.96	106.10	147.01	159.02
LS	NS	NS	NS	*	*
SE±	2.02	3.11	4.21	3.00	1.21
Variety (V)					
Ex-Igbariam	35.08	85.87	124.67	163.23	177.22
Mothers Delight	29.00	72.04	89.46	141.79	150.01
LS	*	**	***	***	***
SE±	0.22	0.34	0.48	0.33	0.54
Soil Volume (SV)					
5 L	30.98	60.03	80.12	114.04	123.23
10 L	32.00	88.19	113.23	160.34	169.17
15 L	34.01	88.23	128.45	183.90	199.48
LS	NS	***	***	***	***
SE±	3.03	3.11	5.12	4.34	4.02
Year (Y)					
2024	25.01	114.23	147.02	178.23	172.78
2025	38.56	43.41	65.09	126.12	156.05
LS	*	***	***	***	*
SE±	3.00	3.12	5.01	3.63	4.22
Interaction					
CT x V	NS	**	NS	***	***
CT x SV	NS	**	*	NS	NS
CT x Y	NS	**	*	NS	NS
V x SV	NS	NS	NS	NS	NS
V x Y	NS	NS	NS	***	***
SV x Y	*	***	NS	NS	NS

LS = Level of significance; SE = Standard error; *** $P \leq 0.001$; ** $P \leq 0.01$; * $P \leq 0.05$; ns ($P > 0.05$)

Table 3: Effects of Container Type, Variety and Soil Volume on Number of Branches of Sweet Potato

Treatments	Weeks After Planting (WAP)				
	6	8	10	12	14
Container Type (CT)					
Bucket	3.11	6.21	7.00	12.23	13.56
Sack	3.21	5.08	7.11	10.01	12.12
LS	NS	NS	NS	*	*
SE±	0.23	1.23	0.89	0.11	0.10
Variety (V)					
Ex-Igbariam	4.34	6.12	7.02	11.24	13.00
Mothers Delight	3.01	5.98	7.11	11.35	12.56
LS	*	NS	NS	NS	NS
SE±	0.12	1.78	0.34	0.79	0.33
Soil Volume (SV)					
5 L	3.00	4.89	5.02	8.10	10.11
10 L	3.23	6.01	8.56	12.24	14.21
15 L	4.12	6.00	8.37	13.78	14.90
LS	NS	NS	***	***	***
SE±	0.98	1.23	0.03	0.04	0.12
Year (Y)					
2024	3.76	6.23	8.58	11.00	11.12
2025	4.03	5.87	6.10	11.21	13.97
LS	NS	NS	**	NS	***
SE±	0.45	1.34	0.05	0.97	0.01
Interaction					
CT x V	NS	NS	NS	NS	NS
CT x SV	NS	NS	NS	NS	NS
CT x Y	NS	NS	NS	NS	NS
V x SV	NS	NS	*	*	**
V x Y	NS	NS	***	NS	NS
SV x Y	NS	NS	NS	*	NS

LS = Level of significance; SE = Standard error; *** $P \leq 0.001$; ** $P \leq 0.01$; * $P \leq 0.05$; ns ($P > 0.05$)

Root Yield

The observed vegetative growth patterns were closely reflected in yield responses. Container size was the dominant factor influencing marketable root yield, with large containers producing significantly higher yields than medium and small containers (Table 4). This correspondence between enhanced canopy development and increased marketable yield indicates that greater vine growth, leaf area, and branching improved assimilate supply for storage root bulking. The findings align with Belehu (2005), who found that larger rooting zones increase assimilate translocation efficiency in Ethiopian sweet potato varieties. Variety also influenced marketable yield, with a significant Variety \times Size interaction, suggesting differential ability of varieties to exploit increased soil volume. Container type again had no significant effect on yield, supporting the conclusions of Ibikunle *et al.* (2025) and Ajisope (2023) that soil volume outweighs container material in determining yield potential under constrained urban environments.

Table 4: Effects of Container, Variety and Soil Volume on Root Yield of Sweet Potato

Treatments	Root Yield (kg)	
	Marketable weight	Unmarketable weight
Container Type (CT)		
Bucket	0.472	0.0617
Sack	0.434	0.0682
LS	NS	NS
SE±	0.0164	0.0076
Variety (V)		
Ex-Igbariam	0.553	0.0543
Mothers Delight	0.354	0.0756
LS	***	**
SE±	0.0164	0.0076
Soil Volume (SV)		
5 L	0.286	0.0737
10 L	0.438	0.0719
15 L	0.636	0.0492
LS	***	*
SE±	0.0201	0.0085
Year (Y)		
2024	0.357	0.0642
2025	0.549	0.0657
LS	***	NS
SE±	0.0162	0.0092
Interaction		
CT x V	NS	NS
CT x SV	NS	NS
CT x Y	NS	NS
V x SV	***	NS
V x Y	NS	NS
SV x Y	NS	NS

LS = Level of significance; SE = Standard error; *** $P \leq 0.001$; ** $P \leq 0.01$; * $P \leq 0.05$; ns ($P > 0.05$)
 Unmarketable root weight was influenced by variety and container size, but not by year or container type (Table 4). Smaller containers tended to produce slightly higher unmarketable yield, likely due to restricted root expansion leading to undersized or malformed roots. Importantly, increased marketable yield in larger containers was not accompanied by increased unmarketable yield, indicating improved yield efficiency rather than a trade-off with root quality. This is consistent with the report by Alhassan (2018) in Ghana, which found that root quality and shape integrity improve with adequate aeration and root expansion space, even in confined containers.

Seasonal Stability of Growth–Yield Relationships

Although year had a significant effect on marketable yield (Table 4) and vegetative growth traits (Table 1, 2 and 3), it did not significantly influence unmarketable yield (Table 4). Moreover, interactions between year and management factors were generally non-significant, indicating that treatment rankings were stable across seasons. This consistency supports the robustness of the observed growth–yield relationships under varying seasonal conditions. McEwan *et al.* (2015) and Abrham *et al.* (2021) similarly reported that sweet potato yield response to soil management and volume constraints remains stable across seasons and soil types when environmental variables are moderately controlled.

Overall, the findings demonstrate that soil volume is the key driver of vegetative growth and yield in container-grown sweet potato, while container material plays a minor role. Larger containers promoted vigorous canopy development during the critical bulking phase (10–14 WAP), resulting in higher marketable yield without increasing unmarketable roots. Variety selection further modulated growth dynamics and yield response, particularly under larger soil volumes. These results provide clear guidance for urban sweet potato cultivation, emphasizing the use of adequate soil volume (≥ 10 –15 L)



and suitable varieties to maximize productivity in container-based systems - corroborating regional findings from Adubasim *et al.* (2017), Ibikunle *et al.* (2025), Belehu (2005), and Paul *et al.* (2020) on optimizing root crop yield efficiency in limited-space cultivation systems.

CONCLUSION AND RECOMMENDATION

This study demonstrates that container soil volume is the primary determinant of vegetative growth and root yield in container-grown sweet potato, while container type plays a comparatively minor role. Larger soil volumes consistently promoted vine elongation, leaf production, and branching, which translated into significantly higher marketable root yield without increasing unmarketable yield. These results confirm that adequate rooting space is essential for both canopy development and efficient storage root bulking under container-based cultivation.

Varietal differences were evident in growth dynamics and yield response to soil volume, highlighting the importance of selecting varieties that can effectively exploit increased rooting space in container systems. In contrast, the functional equivalence of bucket and sack containers indicates that low-cost sack containers can be adopted without yield penalty, provided sufficient soil volume is maintained.

The stability of treatment effects across seasons further supports the robustness of these findings under varying environmental conditions. Collectively, this study provides practical, evidence-based guidance for urban and peri-urban sweet potato production, emphasizing the use of adequate soil volume ($\geq 10\text{--}15$ L) and suitable varieties to maximize productivity and resource-use efficiency in container-based systems.

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