Annals of Phytomedicine 15(1): 969-975, 2026

DOI: http://dx.doi.org/10.54085/ap.2026.15.1.88

Annals of Phytomedicine: An International Journal
http://www.ukaazpublications.com/publications/index.php

Print ISSN : 2278-9839 Online ISSN : 2393-9885

Original Article : Open Access

Impact of corm size and planting density on quality and nutritional composition in Elephant Foot Yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] cv. Gajendra

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Article Info

Article history
Received 22 Febraury 2026
Revised 26 March 2026
Accepted 27 March 2026
Published Online 30 June 2026

Keywords
Quality
Minerals
Nutrients
Corm size
Plant spacing

Abstract

This study examined the effects of plant spacing (60 × 60 cm and 75 × 75 cm) and seed corm size (200 g, 300 g, 400 g and 500 g) on the quality parameters, nutritional composition and mineral content of Elephant Foot Yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] cv. Gajendra. Results showed that wider plant spacing (75 × 75 cm) significantly increased dry matter content and total soluble solids, with the largest seed corms (500 g), showing the highest values for both. Corm weight loss during storage was influenced by seed corm size, with 500 g corms showing the most weight loss, while post-harvest rot was lowest in smaller corms (200 g). In terms of nutritional composition, total sugars, ascorbic acid, total polyphenols, starch content and protein content were significantly higher in larger corms (500 g), though ascorbic acid was higher in corms planted at closer spacing (60 × 60 cm). No significant interaction effects were observed between plant spacing and seed corm size for these parameters. Regarding mineral content, both calcium and phosphorus increased significantly with wider plant spacing and larger seed corm sizes, while iron content was higher in larger corms. The interaction between plant spacing and seed corm size did not significantly affect mineral content. Overall, the study emphasizes the importance of seed corm size and plant spacing in improving quality, nutritional value and storage stability in Elephant Foot Yam cultivation.

1. Introduction

Globally, tuber crops are regarded as the foundation of food security, particularly in tropical and subtropical areas. The crops are valued today for their ability to withstand unfavourable soil and climate conditions, which act as a vital buffer against food scarcity, in addition to their historical contribution to reducing hunger. Almost one-fifth of the world's population is fed by these crops, which are the third most important food group worldwide, after cereals and legumes. They are the major staple food in rural sub-Saharan societies and a growing component of the urban diet (Santosa *et al.,* 2004). Because they are more biologically efficient and adaptable as raw materials for both agro-based businesses and bio-fortified nutritional sources, tuber crops are becoming high-value cash crops in addition to providing immediate food security (Palaniswami and Peter, 2008).

A. paeoniifolius, the scientific name for the Elephant Foot Yam, is a popular tropical tuber crop in the Araceae family. Energy (330 KJ), protein (1.7-5.0%), fat (0.2-0.4%), carbohydrate (18-24%), fiber (0.6-0.8%), ash (0.7-1.3%), calcium (30-56 mg), iron (0.6-2.0 mg), phosphorus (20-30 mg), vitamin A (260-434 IU), thiamine (0.04-0.06 mg), riboflavin (0.05-0.08 mg) and ascorbic acid (3 mg). Because of its high protein, carbohydrate, mineral and other nutrient content, it has been thoroughly studied in traditional Indian medicine (Srivastava *et al.,* 2024). Because of its blood-purifying qualities, tuber has been used in traditional medicine to treat a variety of illnesses, such as rheumatism, splenomegaly, tumours, asthma, dyspnea and gastrointestinal disorders (Singh *et al.,* 2015).

The crop's ability to adapt to marginal soils, its minimal input requirements, and its resilience to severe weather make it viable for agri-food systems in the future. Alkaloids, flavonoids, and phenolics are among the healthy phytochemicals found in the tuber, which are high in fiber and carbs and have potent anti-inflammatory, antidiabetic and antioxidant qualities. These characteristics increase its potential as a sustainable and useful nutraceutical ingredient (Panda *et al.,* 2026).

It is a tropical tuber crop that does well under hot (25-35°C), humid (80-90% RH), and uniformly distributed annual rainfall of 1000-1500 mm (Nedunchezhiyan *et al.,* 2006). According to Nedunchezhiyan and Byju (2005), it is primarily grown in Andhra Pradesh, Gujarat, Maharashtra, West Bengal, North-Eastern states,

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Kerala, Bihar and Uttar Pradesh. Hence, optimizing corm size and planting density is a critical agronomic intervention to improve crop establishment, maximize resource utilization, and enhance the yield potential of Elephant Foot Yam under the agro-ecological conditions of Himachal Pradesh.

2. Materials and Methods

2.1 Plant material

The plant material of Elephant Foot Yam variety 'Gajendra' was procured from the Research Sub Station, Berthin, Bilaspur, for the current study. This variety was developed by CTCRI, Thiruventhapuram. It is a local high yielding selection from the Kovvur area of Andhra Pradesh. It produces smooth corms, free from daughter corms and lacks acridity. This performs very well in eastern and northern India.

2.2 Treatments

The treatments used were different seed corm sizes (C1: 200 g, C2: 300 g, C3: 400 g, and C4: 500 g) and plant spacings (S1: 60 × 60 cm and S2: 75 × 75 cm).

2.3 Experimental details

The present investigation was conducted during the kharif season of 2022 at the Research Farm of the Department of Vegetable Science and Floriculture, CSK HPKV, Palampur, Himachal Pradesh, situated at an altitude of 1300 m above sea level. The experiment was carried out in a subtropical climate, characterized by mild summers and cool winters, with most precipitation occurring during the monsoon period.

2.4 Determination method used

Data was recorded on several quality parameters, including Total soluble solids (°Brix), Dry matter content, Weight loss (%), Post-harvest rot (%), Ascorbic acid (mg/100 g), Total sugars (%), Total polyphenols (mg/100 g), Starch content (%), Protein content (%), Calcium oxalate (mg/100 g) and Mineral content (calcium, phosphorus and iron). The methods used for analysis include the AOAC (1995) standard methods for ascorbic acid and calcium oxalate, Sadasivam and Manickam's (1992) method for total sugars and flame photometer and atomic absorption spectrophotometry for mineral analysis.

2.5 Statistical analysis

The experimental design was a randomised block design (RBD) with three replications. The data were subjected to ANOVA and means were compared using the Critical Difference (CD) at the 5% significance level.

3. Results

3.1 Quality parameters

3.1.1 Dry matter content (%)

The dry matter content of Elephant Foot Yam cv. Gajendra corm was significantly influenced by plant spacing and seed corm size (Table 1). Wider plant spacing (75 × 75 cm) resulted in higher dry matter content compared to closer spacing (60 × 60 cm). Similarly, larger seed corms (500 g) exhibited the highest dry matter content, with a decreasing trend observed in smaller corm sizes (200 g). Each treatment varied significantly from one another.

3.1.2 Total soluble solids (°Brix)

TSS, an indicator of fruit sweetness, was influenced by both plant spacing and seed corm size (Table 1). Wider spacing (75 × 75 cm) resulted in higher TSS content compared to closer spacing (60 × 60 cm). The highest TSS was recorded with 500 g seed corms, while 200 g corms had the lowest. The interaction between plant spacing and seed corm size had no significant effect on TSS.

3.1.3 Corm weight loss (%)

Freshly harvested Elephant Foot Yam cv. Gajendra corm, with 75-80% moisture, requires proper storage conditions to enhance shelf-life (Sahu and Kumar, 2017). Data on weight loss at 30, 60 and 90 days after storage (DAS) revealed that plant spacing did not significantly affect weight loss. However, seed corm size significantly influenced weight loss, with 500 g seed corms showing the most weight loss, followed by 400 g and 300 g (Figure 1). The interaction between plant spacing and seed corm size had no significant effect on weight loss during storage.

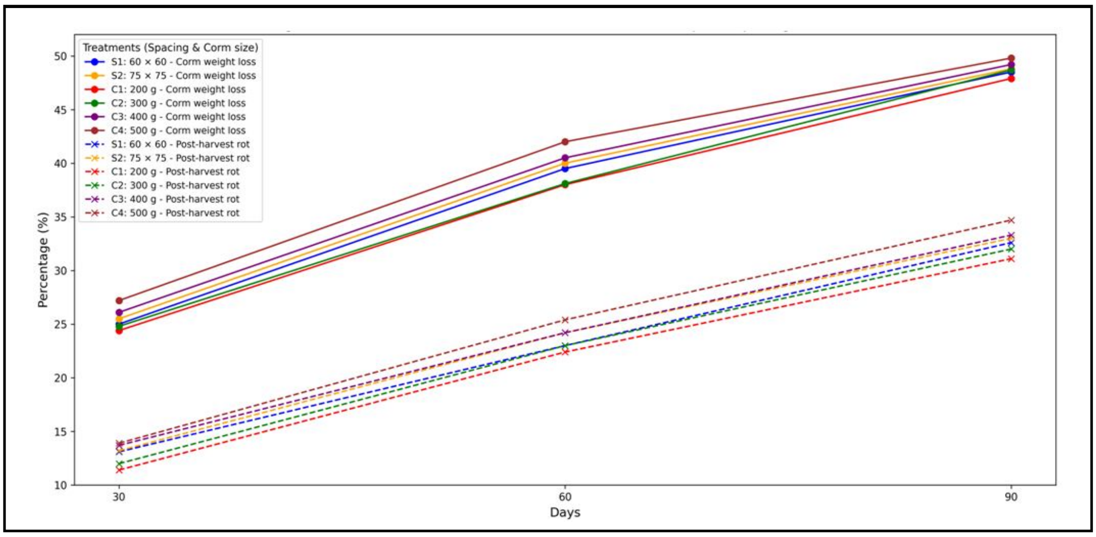

Figure 1: Effect of plant spacing and corm size on weight loss and post-harvest rot of Elephant Foot Yam.

3.1.4 Post-harvest rot (%)

Post-harvest rot, caused by pathogens such as *Phytophthora colocasiae* and *Sclerotium rolfsii*, is a major problem in the storage of Elephant Foot Yam (Arunasri *et al.,* 2011). Data recorded at 30, 60 and 90 DAS (Table 2) showed that plant spacing had no significant effect on post-harvest rot, but seed corm size had a significant effect. The smallest corm size (200 g) exhibited the least rot, while the largest corm size (500 g) showed the highest rot at all storage stages. The interaction between plant spacing and seed corm size did not significantly affect post-harvest rot.

3.1.5 Calcium oxalate content (mg/100 g)

Calcium oxalate, an antinutritional factor, was significantly higher in corms planted at closer spacing (60 × 60 cm) and with smaller seed corms (200 g) (Table 1). The interaction between plant spacing and seed corm size had no significant effect on calcium oxalate content.

3.2 Nutritional composition

3.2.1 Total sugars (%)

Total sugar content in Elephant Foot Yam cv. Gajendra was significantly influenced by seed corm size, with wider plant spacing (75 × 75 cm) yielding higher sugar content (1.98%) than closer spacing (1.90%). The highest sugar content was recorded in 500 g seed corms, and the lowest in 200 g corms (Table 3). The interaction between plant spacing and seed corm size had no significant effect on total sugars.

3.2.2 Ascorbic acid (mg/100 g)

Ascorbic acid was significantly higher with closer plant spacing (60 × 60 cm). Seed corms weighing 200 g recorded the highest ascorbic acid, followed by 300 g, 400 g and 500 g corms (Table 3). The interaction between plant spacing and seed corm size had no significant effect on ascorbic acid content.

3.2.3 Total polyphenols (mg/100 g)

Polyphenol levels, which improve human physiological functions, were significantly higher in 500 g seed corms, followed by 400 g, 300 g and 200 g (Figure 2). Plant spacing had no significant effect on polyphenol content, and the interaction between spacing and corm size was not significant.

3.2.4 Starch content (%)

Starch content, a primary food energy source, was significantly higher with wider plant spacing (75 × 75 cm) and larger seed corm sizes (Table 3). The highest starch content was recorded in 500 g corms, followed by 400 g, 300 g and 200 g corms. The interaction between plant spacing and seed corm size had no significant effect on starch content.

3.2.5 Protein content (%)

Protein content was significantly affected by both plant spacing and seed corm size, with larger seed corms (500 g) having the highest protein content. Wider plant spacing also resulted in higher protein content (Table 4). The interaction between plant spacing and seed corm size had no significant effect on protein content.

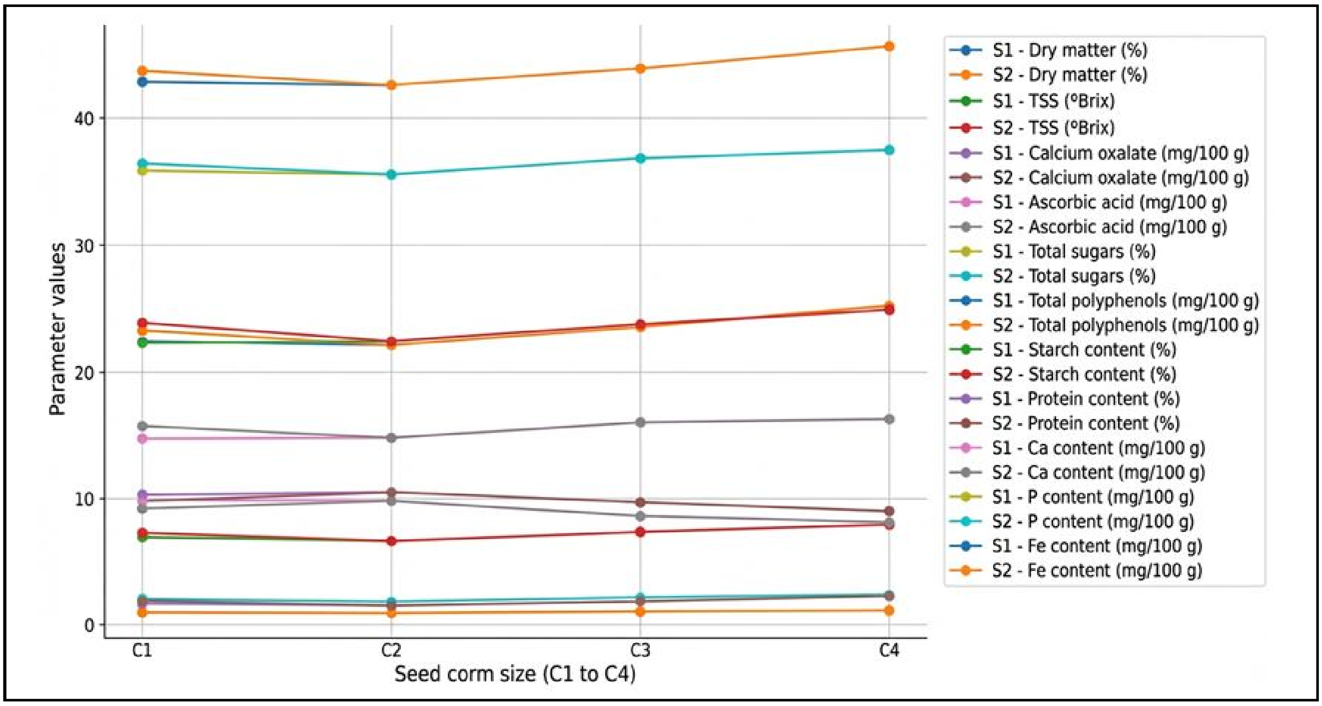

Figure 2: Effect of plant spacing and seed corm size on different parameters of Elephant Foot Yam.

3.2.6 Mineral content (Ca, P and Fe (mg/100 g))

Data on calcium, phosphorus and iron content in the Gajendra variety of Elephant Foot Yam revealed that calcium and phosphorus content increased significantly with wider plant spacing (75 × 75 cm) and larger seed corm sizes (200 g to 500 g). No significant differences in corm size were observed between 400 g and 500 g. Iron content increased with corm size, with no significant effect from plant spacing. The interaction between plant spacing and seed corm size had no significant effect on calcium, phosphorus and iron content (Table 4).

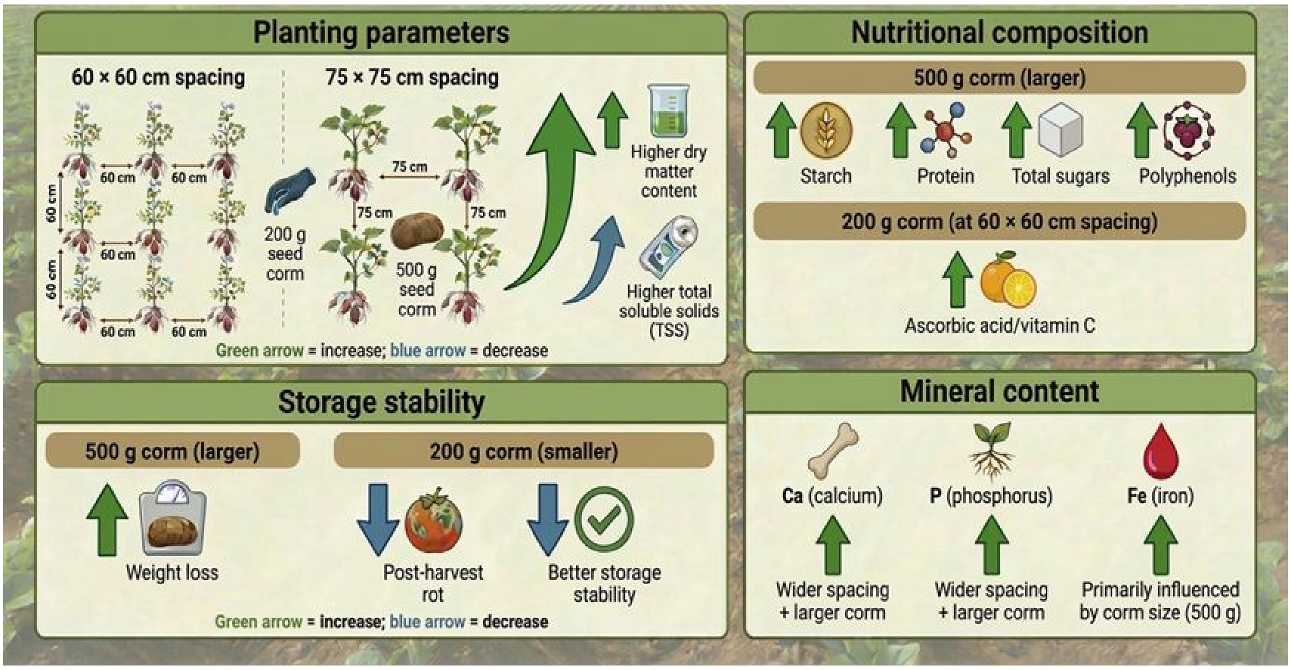

Figure 3: Diagrammatic depiction of how plant spacing and seed corm size affect Elephant Foot Yam.

Table 1: Impact of corm size and planting density on dry matter, total soluble solids and calcium oxalate

Treatments	Dry matter (%)	Total soluble solids (°Brix)	Calcium oxalate (mg/100 g)
Plant spacing in cm (S)			
S_1: 60 × 60	22.48	6.93	10.33
S_2: 75 × 75	23.35	7.26	9.84
SE(m) ±	0.20	0.09	0.13
CD (p=0.05)	NS	0.30	0.42
Seed corm size in g (C)			
C1: 200	20.57	6.48	11.08
C2: 300	22.18	6.62	10.51
C3: 400	23.60	7.34	9.74
C4: 500	25.31	7.93	9.01
SE(m) ±	0.29	0.13	0.19
CD (p=0.05)	0.90	0.42	0.59
Interaction (S × C)			
CD (p=0.05)	NS	NS	NS

Table 2: Impact of corm size and planting density on corm weight loss and post-harvest rot

Treatments	Corm weight loss (%)			Post-harvest rot (%)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Plant spacing in cm (S)						
S_1: 60 × 60	25.84	39.63	48.33	13.00	23.11	32.57
S_2: 75 × 75	25.51	40.19	49.43	12.35	24.23	32.95
SE(m) ±	0.16	0.29	0.23	0.26	0.24	0.55
CD (p = 0.05)	NS	NS	NS	NS	NS	NS

Seed corm size in g (C)						
C1: 200	24.45	37.98	47.91	11.33	22.32	31.06
C2: 300	24.90	39.31	48.79	11.84	22.82	31.99
C3: 400	26.14	40.45	49.13	13.66	24.22	33.33
C4: 500	27.24	41.90	49.69	13.87	25.33	34.66
SE(m) ±	0.23	0.41	0.32	0.37	0.34	0.78
CD (p = 0.05)	0.71	1.26	1.00	1.61	1.05	2.40
Interaction (S × C)						
CD (p = 0.05)	NS	NS	NS	NS	NS	NS

Table 3: Impact of corm size and planting density on ascorbic acid, total sugars, total polyphenols and starch content

Treatments	Ascorbic acid (mg/100 g)	Total sugars (%)	Total polyphenols (mg/100 g)	Starch content (%)
Plant spacing in cm (S)				
S_1: 60 × 60	9.90	1.90	42.83	22.35
S_2: 75 × 75	9.24	1.98	43.68	23.94
SE(m) ±	0.21	0.03	0.31	0.13
CD (p=0.05)	0.64	NS	NS	0.40
Seed corm size in g (C)				
C1: 200	11.72	1.56	40.98	21.28
C2: 300	9.82	1.77	42.59	22.49
C3: 400	8.62	2.10	43.87	23.82
C4: 500	8.13	2.33	45.59	25.00
SE(m) ±	0.29	0.05	0.44	0.18
CD (p=0.05)	0.90	0.16	1.36	0.57
Interaction (S × C)				
CD (p=0.05)	NS	NS	NS	NS

Table 4: Impact of corm size and planting density on protein, Ca, P and Fe content

Treatments	Protein content (%)	Ca content (mg/100 g)	P content (mg/100 g)	Fe content (mg/100 g)
Plant spacing in cm (S)				
S_1: 60 × 60	1.61	14.78	35.89	0.88
S_2: 75 × 75	1.82	15.78	36.44	0.93
SE(m) ±	0.04	0.15	0.15	0.01
CD (p=0.05)	0.90	0.16	1.36	0.57
Seed corm size in g (C)				
C1: 200	1.38	13.89	34.72	0.71
C2: 300	1.46	14.84	35.60	0.85
C3: 400	1.78	16.06	36.84	0.98
C4: 500	2.23	16.33	37.51	1.06
SE(m) ±	0.06	0.21	0.22	0.01
CD (p=0.05)	0.18	0.65	0.67	0.05
Interaction (S × C)				
CD (p=0.05)	NS	NS	NS	NS

4. Discussion

The findings show that cv. Gajendra is a significant source of essential elements, including protein, ascorbic acid, total sugars, total polyphenols and starch. Corm is rich in iron, zinc, calcium, manganese, potassium, phosphorus, flavonoids and antioxidants in addition to being a high-energy food (Shilpi *et al.,* 2005 and Santosa *et al.,* 2002). These components are essential to human physiology. Panda *et al.* (2025) and Sarkar *et al.* (2025) conducted comparable research on the corresponding minerals. Calcium oxalate crystals are thought to be responsible for acridity (Sarkar *et al.,* 2025).

Recent pharmacological studies have further highlighted the therapeutic potential of Elephant Foot Yam, identifying bioactive compounds such as glucomannan and betulinic acid that contribute to its documented antioxidant, anti-inflammatory, antidiabetic and hepatoprotective activities (Singh *et al.,* 2023). Furthermore, the corm has shown promise in managing metabolic disorders, with research associating its consumption with reductions in blood glucose, lipids and body weight (Singh *et al.,* 2023).

Renal stones and, in extreme situations, renal failure are caused by oxalate clusters lodging in the kidney. Over 75% of kidney stones are caused by oxalates and consuming oxalate-containing foods increases urine oxalate levels to varying degrees (Pramod *et al.,* 2012). Due to oxalate and acridity, EFY has been mostly underutilised (Srivastava *et al.,* 2022 and Panda *et al.,* 2025).

According to related studies by Koni *et al.* (2017), Navya *et al.* (2017), Punna *et al.* (2018), and Rahman *et al.* (2021), Elephant Foot Yam has significant concentrations of Ca, Fe, and P on a dry-weight basis. Beyond its traditional use, the corm is gaining industrial interest as a functional food ingredient due to its high content of resistant starch and dietary fiber (Shahbuddin *et al.,* 2025). The degree of quality and stability of the corms in storage should be assessed by monitoring physiological measures such as total soluble solids (°Brix), dry matter content and weight loss, which are closely related to the corm's metabolic activity. Additionally, a significant problem affecting farmers and the crop's economic viability is susceptibility to post-harvest rot, necessitating the development of value-added products, such as dried or fried cubes, to extend shelf life and enhance marketability (Singh *et al.,* 2020).

5. Conclusion

The present study on Elephant Foot Yam (cv. Gajendra) demonstrated that plant spacing and seed corm size significantly influenced quality parameters, nutritional composition and mineral content. Wider plant spacing (75 × 75 cm) resulted in higher dry matter content and total soluble solids (TSS), while larger seed corms (500 g) showed the highest values for both parameters. Weight loss during storage was primarily influenced by seed corm size, with larger corms (500 g) experiencing the most weight loss. Post-harvest rot was lowest in smaller seed corms (200 g), highlighting their superior storage stability. In terms of nutritional composition, total sugars, polyphenols, starch content and protein were higher in larger seed corms, while ascorbic acid was higher with smaller corms and closer spacing (60 × 60 cm). Mineral content of calcium and phosphorus increased with wider spacing and larger seed corm sizes (200 g to 500 g), while iron content was more influenced by seed corm size than plant spacing. The interaction between plant spacing and seed corm size showed no significant effect on mineral content. These findings highlight the importance of seed corm size and plant spacing in improving the nutritional quality, storage stability and overall quality of Elephant Foot Yam, with potential implications for post-harvest management and crop improvement.

Acknowledgments

The authors express gratitude to CSK HPKV, Palampur, India, for financial assistance that facilitated the completion of this research.

Conflict of interest

The authors declare no conflicts of interest relevant to this article

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Citation **Dinesh Kumar, Shivani, Ravinder Singh, Mokkala Siva Prasad, Khushwant Singh, Laikangbam Phonia and Neha Jamwal (2026). Impact of corm size and planting density on quality and nutritional composition in Elephant Foot Yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] cv. Gajendra. Ann. Phytomed., 15(1):969-975, http://dx.doi.org/10.54085/ap.2026.15.1.88.**