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Influence of different levels of fertilizer with biofertilizers on growth attribute and yield parameter of elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.)] in lateritic soils of Konkan

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ABSTRACT

A field experiment was conducted during the Kharif–Rabi seasons of 2023–24 and 2024–25 at the All India Coordinated Research Project on Tuber Crops, Central Experiment Station, Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, to evaluate the effect of integrated nutrient management on elephant foot yam. The experiment was laid out in a factorial randomized block design with three replications, comprising three fertilizer levels (0%, 75%, and 100% of the recommended dose of fertilizers, RDF) and five biofertilizer treatments (no biofertilizer, Azotobacter + PSB, Azotobacter, *Azospirillum* + PSB, and *Azospirillum* + VAM). There was 15 treatments combination. Growth observations like plant height, Canopy spread and were recorded periodically at 45, 80, 120 days after plantation (DAP) of elephant foot yam were as Total dry matter weight was recorded from bulking stage of corms i.e. 120, 160, and 180 days after planting (DAP). The yield of corm and single weight of corm were recorded at harvest during 2023-24 and 2024-25.

The study revealed that the integrated application of 100% recommended dose of fertilizers (RDF) with Azotobacter + PSB @ 10 kg ha⁻¹ each (F_{2B1}) significantly improved soil fertility by increasing the availability of N, P, K, Fe, and Mn. The F_{2B1} treatment also recorded the maximum single corm weight, Yield (t ha⁻¹). Application of 100% RDF alone produced the highest average corm yield (22.58 and 21.46 t ha⁻¹ during 2023–24 and 2024–25, respectively), whereas the control recorded the lowest yield (8.72 and 8.51 t ha⁻¹). Among the biofertilizer treatments, Azotobacter + PSB achieved the highest yields (20.89 and 20.20 t ha⁻¹), and the RDF × biofertilizer interaction significantly enhanced productivity, with yields ranging from 7.11–28.67 t ha⁻¹ in 2023–24 and 6.84–27.84 t ha⁻¹ in 2024–25.

The integrated application of 100% RDF + Azotobacter + PSB (F_{2B1}) significantly enhanced the growth of elephant foot yam by recording the highest plant height, canopy spread, total dry matter production recorded with 100% RDF (F_2) during both years. Among the biofertilizer treatments Azotobacter + PSB @ 10 kg ha⁻¹ each (B_1). The combine application RDF along with biofertilizers found highest with 100% RDF and Azotobacter + PSB (B_1), whereas lower values were observed under Azotobacter + VAM, *Azospirillum* + VAM, and control treatments.

Therefore, integrating the recommended dose of fertilizers with Azotobacter + PSB is an effective, economically viable, and sustainable nutrient management strategy for elephant foot yam cultivation under Konkan lateritic soils.

Keywords: Elephant foot yam, Lateritic soil, Azotobacter, PSB, *Azospirillum*, VAM, Plant height, Canopy spread, Corm yield

Introduction

Elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.), syn. *A. campanulatus* (Roxb.)) is an important tropical tuber crop native to Southeast Asia and widely cultivated in India for its high yield potential, adaptability, and nutritional value. It is a popular vegetable used in several Indian cuisines and is also valued for its medicinal properties. Major producing states include West Bengal, Andhra Pradesh, Gujarat, Kerala, and Tamil Nadu, with cultivation also expanding to Maharashtra, Uttar Pradesh, and Jharkhand. The crop is often grown as an intercrop in coconut and banana plantations due to its efficient land use. In India, elephant foot yam is cultivated on about 40,000–42,100 ha, producing nearly 1.0 million tonnes annually, with an average productivity of 24.74 t ha⁻¹ (GOI, 2023; Byju & Jaganathan, 2025) [1]. Research in the Konkan region has highlighted the importance of improved production technologies, with the variety Gajendra recording a su

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perior yield of 26 t ha⁻¹, demonstrating its potential for enhancing productivity under diverse agro-climatic conditions (Mhaskar *et al.*, 2020) [2].

Tuber crops are the third most important food group after cereals and grain legumes, serving as a major source of energy for nearly one-fifth of the world's population. They are valuable as secondary staple foods, vegetables, and raw materials for feed and agro-based industries. Rich in carbohydrates, dietary fibre, beta-carotene, antioxidants, and essential minerals, these crops contribute significantly to nutritional security and rural livelihoods. Their ability to thrive under marginal conditions, low-input farming, and mixed cropping systems makes them particularly important for smallholder farmers. Tuber crops exhibit considerable resilience to climatic stresses, including drought, excessive rainfall, waterlogging, and temperature extremes, making them well suited to coastal agro-climatic conditions (Mhaskar *et al.*, 2017) [3]. In Maharashtra, crops such as cassava, sweet potato, elephant foot yam, colocasia, xanthosoma, aerial yam, and yam bean have good cultivation potential as sole crops or as components of diversified cropping systems.

Balanced nutrient management through the combined application of the recommended dose of fertilizers (RDF) and biofertilizers improves the growth and yield of elephant foot yam by enhancing nutrient availability, uptake, and fertilizer-use efficiency. In the acidic lateritic soils of the Konkan region, this integrated approach helps maintain soil fertility, reduces nutrient losses, and promotes sustainable and higher crop productivity.

1.2. Importance of study

Nutritional composition

Elephant foot yam is a nutritious tuber crop rich in minerals and moderate in protein content. The protein content (1.126%) observed in the tubers was within the range reported for Indian cultivars (0.84–2.6%) by Chattopadhyay *et al.* (2009). Studies by Paul *et al.* (2013) [4] also reported that elephant foot yam is rich in minerals such as calcium, phosphorus, and iron, though comparatively low in protein. The crop is considered a valuable source of essential minerals that support enzymatic regulation, bone development, acid–base balance, and muscle function. Top of Form

Bottom of Form

Anti-nutrient content

Anti-nutrient factors can influence animals in several manners, including directly intoxicating the animals, causing mortality or decreased production Cheeke *et al.*, (1995) and decreasing feed intake. The oxalate concentration was 31.851 mg/100 g, which is higher than that reported for cultivars in India (2.91–18.50 mg/100 g) Chattopadhyay (2009). The oxalate content in plants is affected by many factors, including the season, soil, water, climatic conditions and where the plant is grown. Oxalates can bind with calcium to form insoluble calcium oxalate, reducing calcium availability and potentially causing hypocalcemia and kidney stone formation in humans (Paul *et al.*, 2013) [4]. However, ruminants such as cattle and sheep are less affected due to oxalate degradation in the rumen (Allison *et al.*, 2001).

Climate and soil

Elephant foot yam is a tropical/subtropical crop and hence thrives well under warm humid climate with a mean annual temperature of 30–35 °C and a well distributed rainfall of 1000 - 1500 mm spread over a period of 6–8 months. It grows well on a variety of soils, but a well-drained sandy loam or sandy clay loam soil with a near neutral soil reaction (pH 6–7) is ideally suited for the crop. The soil should be rich in organic matter with adequate amount of available nutrients. In elephant foot yam corms of 500 g planted at 75 x 75 cm produced highest tuber yield, net returns and benefit: cost ratio Mhaskar *et al.* (2016) [5]. Elephant foot yam is important for developing sustainable nutrient management practices in the lateritic soils of the Konkan region. Lateritic soils are generally acidic, low in fertility and deficient

in essential nutrients, which adversely affect crop growth and yield. Thus integrating biofertilizers such as *Azotobacter*, *Azospirillum*, phosphate-solubilizing bacteria (PSB), and vesicular arbuscular mycorrhiza (VAM) with chemical fertilizers can improve nutrient availability, enhance soil microbial activity, and increase nutrient uptake efficiency.

Such combinations may help reduce dependence on chemical fertilizers while maintaining or improving yield, quality and soil health. Evaluating different RDF levels along with biofertilizer consortia can identify the most efficient and economical nutrient management strategy for elephant foot yam cultivation under Konkan conditions. Implementation of biological control methods as the earliest effort in the plant pathogen interactive environment offers an attractive way to replace chemical fertilizers, pesticides, and other supplements, manage pathogen and pest control in crops, and increase crop production in an environment-friendly manner (Panth *et al.*, 2020) [6].

Material and Method

In the present investigation an attempt has been made to study the "Influence of different levels of fertilizer with biofertilizers on soil properties, yield, quality and nutrient content of elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.)] in lateritic soils of Konkan" at research farm of All India Co-ordinated Research Project on Tuber Crop, Central Experiment Station Wakawali, Tal. Dapoli, Dist. Ratnagiri during Kharif – Rabi season of the year 2023–2024 and 2024–2025, where effect of three levels of fertilizers i.e. 0%, 75% and 100% RDF with four types of biofertilizer combinations i.e. *Azotobacter* + PSB, *Azospirillum* + PSB, *Azotobacter* + VAM, and *Azospirillum* + PSB on Growth parameter and yield of elephant foot yam. The soil of experimental plot was sandy loam in texture, moderately acidic in reaction (5.34) with low electrical conductivity (0.27 dS m⁻¹) having very high content of organic carbon (14.23 g kg⁻¹). It was medium in available nitrogen (323.00 kg ha⁻¹), very low in available phosphorous (7.88 kg ha⁻¹) and very high in available potassium (426.12 kg ha⁻¹) content in its initial physio-chemical analysis. In general, it can be concluded that soil of experimental site indicated typical lateritic soil of Konkan region. The test crop used was elephant foot yam cv. *Gajendra*. Corm of elephant foot yam were used as a propagation material of 500g. Corm of elephant foot yam were planted in June with the onset of rain and were harvested 180 days after sowing.

Application of RDF dose of phosphorus was given at the time of planting and half dose of nitrogen and potassium were given at 45 days after planting and remaining half at 75 days after planting i.e. at earthing up operation. The nitrogen, phosphorous and potassium were applied through urea, single super phosphate, muriate of potash through chemical fertilizers, respectively. Were as biofertilizers like *Azotobacter*, Phosphate Solubilizing Bacteria (PSB), *Azospirillum*, Vascular Arbuscular Mycorrhiza (VAM) @ 10 kg ha⁻¹ each with *Trichoderma viride* @ 10 kg and FYM @ 12 tonnes ha⁻¹ was given at time of planting.

The observations and analytical values obtained during course of study were analyzed statistically. Effect of different levels of fertilizer with biofertilizers on growth of elephant foot yam, including number of days taken for 50% and 100% sprouting, plant height (cm), canopy spread (cm), dry matter production as influenced by varying levels of fertilizers (0,75 and 100% RDF) and biofertilizers (*Azotobacter* + PSB, *Azospirillum* + PSB, *Azotobacter* + VAM, and *Azospirillum* + PSB), Growth observations like plant height, Canopy spread and were recorded periodically at 45, 80, 120 days after plantation (DAP) of elephant foot yam were as Total dry matter weight was recorded from bulking stage of corms ie. 120, 160, and 180 days after planting (DAP). As the crop progressed from 120 to 180 DAP, the accumulation of dry matter increased due to continued photosynthesis and translocation of assimilates from the shoot to the developing corms and are presented in Tables 1, 2, 3 and 4. The single corm weight (g), yield (t ha⁻¹) of elephant foot yam at harvested corms of both seasons which presented in table no 5.

1. Number of days taken for 50% and 100% sprouting

The results revealed that the number of days taken for 50% and 100% sprouting of elephant foot yam was not significantly influenced by different fertilizer levels, biofertilizer treatments, or their interactions during both years of experimentation. Although numerical differences were observed, these were statistically non-significant, indicating that sprouting is mainly governed by physiological factors such as corm maturity, dormancy, corm size, and stored food reserves rather than nutrient application. Among fertilizer levels, 100% RDF recorded the least number of days for both 50% and 100% sprouting, while the control (0% RDF) required relatively more days. Similarly, among biofertilizer treatments, *Azotobacter* + PSB showed the earliest sprouting, followed by other biofertilizer combinations, whereas the control without biofertilizers took comparatively longer. The interaction treatment 100% RDF + *Azotobacter* + PSB (F_2B_1) consistently recorded the minimum number of days for sprouting during both years and in pooled analysis, though the differences were not statistically significant. The slight numerical improvement under integrated nutrient management may be attributed to better nutrient availability and the production of plant growth-promoting substances such as auxins, gibberellins, and cytokinins by *Azotobacter*, along with enhanced phosphorus availability through PSB, which together promote early bud activation and sprouting. These findings are in agreement with

Biswanath *et al.* (2019), who reported that fertilizer application had no significant effect on sprouting of elephant foot yam and concluded that sprouting is primarily controlled by corm characteristics and environmental conditions. Likewise, Gokul *et al.* (2023) [7] reported that integrated nutrient management involving FYM, vermicompost, RDF, and consortium biofertilizers applied after planting did not significantly alter sprouting behaviour, although slight numerical improvements in early emergence were observed under integrated nutrient management practices.

2. Plant height (cm)

Effect of fertilizer levels

Different fertilizer levels significantly influenced plant height of elephant foot yam throughout the crop growth period. The tallest plants were recorded with 100% RDF (F_2), followed by 75% RDF (F_1), while the control (F_0) recorded the lowest plant height. Improved nutrient availability under higher RDF enhanced cell division, stem elongation, and vegetative growth. Similar findings were reported by Venkatesan *et al.* (2013) [8], Jata *et al.* (2015), and Choudhary *et al.* (2012).

Table 1. Number of days taken for 50 and 100% sprouting of elephant foot yam as influenced by different fertilizer levels with biofertilizers during Kharif–Rabi, 2023–24 and 2024–25.

Number of days taken for 50% sprouting of elephant foot yam Kharif–Rabi, 2023–24 and 2024–25												
Treat	50 % sprouting during 2023-24				50 % sprouting during 2024-25				Pooled			
	F_0	F_1	F_2	Mean	F_0	F_1	F_2	Mean	F_0	F_1	F_2	Mean
B_0	24.98	24.84	24.52	24.78	26.45	26.25	26.17	26.29	25.71	25.55	25.35	25.54
B_1	24.20	23.58	23.25	23.68	25.40	25.05	24.49	24.98	24.80	24.32	23.87	24.33
B_2	24.74	24.39	24.15	24.43	26.24	25.89	25.52	25.88	25.49	25.14	24.84	25.16
B_3	25.05	23.55	23.38	24.00	25.45	25.08	24.98	25.17	25.25	24.32	24.18	24.58
B_4	24.92	24.69	24.37	24.66	25.58	25.52	25.45	25.52	25.25	25.11	24.91	25.09
Mean	24.78	24.21	23.93		25.82	25.56	25.33		25.30	24.89	24.63	
	F	B	$F \times B$		F	B	$F \times B$		F	B	$F \times B$	
S.Em±	0.26	0.34	0.59		0.25	0.32	0.56		0.23	0.29	0.51	
C.D. @5%	NS	NS	NS		NS	NS	NS		NS	NS	NS	
Number of days taken for 100 % sprouting of elephant foot yam Kharif–Rabi, 2023–24 and 2024–25												
Treat	100 % sprouting during 2023-24				100 % sprouting during 2024-25				Pooled			
	F_0	F_1	F_2	Mean	F_0	F_1	F_2	Mean	F_0	F_1	F_2	Mean
B_0	35.26	35.78	33.27	34.77	35.65	35.18	35.10	35.31	35.46	35.14	34.19	34.93
B_1	34.18	33.51	33.15	33.62	35.18	34.47	34.09	34.58	34.44	33.99	33.62	34.02
B_2	34.67	34.32	34.21	34.40	35.46	35.07	34.68	35.07	34.80	34.70	34.44	34.65
B_3	34.30	33.87	33.58	33.92	35.29	34.71	34.41	34.80	34.68	34.29	34.00	34.32
B_4	34.86	34.80	34.26	34.64	35.57	35.11	34.92	35.20	35.22	34.96	34.59	34.92
Mean	34.66	34.46	33.69		35.43	34.91	34.64		34.92	34.62	34.17	
	F	B	$F \times B$		F	B	$F \times B$		F	B	$F \times B$	
S.Em±	0.34	0.45	0.77		0.27	0.35	0.61		0.21	0.27	0.46	
C.D. at 5%	NS	NS	NS		NS	NS	NS		NS	NS	NS	

Effect of biofertilizers

Biofertilizer application significantly increased plant height over the control. *Azotobacter* + PSB (B_1) recorded the highest plant height, followed by *Azospirillum* + PSB (B_3). The enhanced growth may be attributed to biological nitrogen fixation, phosphorus solubilization, and the production of plant growth-promoting substances, which improved nutrient uptake and plant development. Similar results were reported by Navya *et al.* (2017) [9].

Combined effect of fertilizer levels and biofertilizers

The interaction between fertilizer levels and biofertilizers was non-significant at 40 DAP but significant from 80 DAP onwards. The combination of 100% RDF + *Azotobacter* + PSB (F_2B_1) consistently recorded the maximum plant height, indicating the synergistic effect of inorganic fertilizers and biofertilizers on nutrient availability and vegetative growth. These findings are in agreement with Saroj (2020) [10], Navya *et al.* (2017) [9], and Piyush *et al.* (2025) [11].

3. Canopy spread (cm)

Effect of fertilizer levels

Different fertilizer levels significantly influenced canopy spread of elephant foot yam. 100% RDF (F₂) recorded the maximum canopy spread at all growth stages, followed by 75% RDF (F₁), while the control (F₀) recorded the lowest values. The increased canopy spread under higher RDF may be attributed to adequate and balanced nutrient supply, particularly N, P, and K, which promoted leaf expansion, photosynthesis, and vigorous vegetative growth. Similar findings were reported by Biswanath *et al.* (2014) [12], Venkatesan *et al.* (2013) [8], and Choudhary *et al.* (2012).

Effect of biofertilizers

Biofertilizer application significantly increased canopy spread over the control. Among the treatments, Azotobacter + PSB (B₁) recorded the maximum canopy spread, followed by *Azospirillum* + PSB (B₃). The superior performance of B₁ may be attributed to enhanced nitrogen fixation, phosphorus solubilization, and improved nutrient uptake, resulting in greater leaf expansion and canopy development. Treatments involving VAM recorded comparatively lower canopy spread due to relatively slower phosphorus availability under lateritic soil conditions. Similar results were reported by Devendra *et al.* (2020) [13].

Combined effect of fertilizer levels and biofertilizers

The interaction between fertilizer levels and biofertilizers was non-significant at 40 DAP but significant at 80, 120, and 160 DAP. The combination of 100% RDF + Azotobacter + PSB (F₂B₁) consistently recorded the highest canopy spread, indicating the synergistic effect of inorganic fertilizers and biofertilizers in improving nutrient availability and vegetative growth. Similar observations were reported by Navya *et al.* (2017) [9] under integrated nutrient management in elephant foot yam.

4. Total dry matter (shoot + corm) production (g)

Effect of fertilizer levels

Different fertilizer levels significantly influenced total dry matter production of elephant foot yam at 120, 160, and 180 DAP. 100% RDF (F₂) recorded the highest dry matter accumulation, followed by 75% RDF (F₁), while the control (F₀) recorded the lowest values. The higher dry matter under 100% RDF may be attributed to the adequate supply of N, P, and K, which enhanced photosynthesis, nutrient uptake, biomass production, and translocation of assimilates to the developing corm. Similar findings were reported by Laxminarayana *et al.* (2024) [14] and Jata *et al.* (2015).

Table 2. Plant height (cm) of elephant foot yam at different growth stages as influenced by different fertilizer levels with biofertilizers during Kharif-Rabi, 2023–24 and 2024–25

Plant height (cm) of elephant foot yam at different growth stages during Kharif-Rabi, 2023–24																
Treat	40 DAP				80 DAP				120 DAP				160 DAP			
	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean
B ₀	39.08	40.33	43.26	40.89	42.52	51.21	36.30	43.34	50.52	49.21	52.30	50.68	63.86	67.54	77.30	69.57
B ₁	45.57	59.46	66.28	57.10	51.03	76.10	76.58	67.90	56.36	90.10	90.91	79.12	61.36	97.58	99.10	86.01
B ₂	35.57	53.57	57.94	49.03	40.39	64.30	65.80	56.83	55.04	75.13	76.96	69.04	63.37	93.46	89.96	82.27
B ₃	40.90	55.01	56.31	50.74	47.51	66.32	70.01	61.28	56.10	80.32	89.34	75.25	64.44	93.99	97.67	85.37
B ₄	37.32	50.05	49.18	45.52	44.61	49.04	64.25	52.63	60.61	68.38	70.25	66.41	68.94	80.04	91.91	80.30
Mean	39.69	51.95	54.33		45.21	61.79	62.19		55.73	72.79	75.79		64.39	86.52	91.19	
	F	B	F×B		F	B	F×B		F	B	F×B		F	B	F×B	
S.Em±	1.78	2.29	3.97		2.18	2.81	4.87		2.07	2.67	4.63		2.10	2.71	4.69	
C.D. @ 5%	5.15	6.65	NS		6.31	8.15	14.12		5.99	7.74	13.40		6.07	7.84	13.57	
Plant height (cm) of elephant foot yam at different growth stages during Kharif-Rabi, 2024–25																
Treat	40 DAP				80 DAP				120 DAP				160 DAP			
	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean
B ₀	35.19	43.44	43.63	40.75	42.86	39.21	42.30	41.46	53.82	55.88	56.30	55.33	67.09	69.44	78.53	71.69
B ₁	45.88	57.94	59.33	54.38	50.36	80.10	80.91	70.46	59.96	89.91	91.50	80.32	70.93	106.15	107.33	94.80
B ₂	43.79	51.78	53.46	49.68	51.04	65.13	66.96	61.04	52.07	76.46	80.30	69.61	67.94	98.70	98.53	88.39
B ₃	40.98	53.14	56.07	50.06	51.44	70.32	79.34	67.03	57.08	80.32	89.34	75.58	69.00	101.89	102.91	91.27
B ₄	39.96	45.19	51.80	45.65	50.61	58.38	60.25	56.41	60.97	68.38	70.25	66.53	67.17	71.94	87.15	75.42
Mean	41.16	51.22	51.94		49.26	62.79	65.79		56.78	74.39	77.26		68.43	89.62	94.89	
	F	B	F×B		F	B	F×B		F	B	F×B		F	B	F×B	
S.Em±	1.54	1.99	3.44		2.08	2.69	4.66		2.04	2.64	4.57		2.25	2.90	5.03	
C.D. at 5%	4.46	5.75	NS		6.04	7.79	13.50		5.92	7.64	13.24		6.51	8.41	14.56	

Effect of biofertilizers

Biofertilizer application significantly increased total dry matter production over the control. Among the treatments, Azotobacter + PSB (B₁) recorded the highest dry matter accumulation at all growth stages. This improvement may be due to enhanced nitrogen fixation, phosphorus solubilization, improved root growth, and greater photo-

synthetic efficiency, resulting in higher biomass accumulation. Treatments involving VAM and *Azospirillum* alone were comparatively less effective under lateritic soils because of limited phosphorus availability and reduced microbial efficiency. Similar results were reported by Nedunchezhiyan *et al.* (2017) [15] and Devendra *et al.* (2020) [13].

Table 3. Canopy spread (cm) of elephant foot yam at different growth stages as influenced by different fertilizer levels with biofertilizers during *Kharif-Rabi*, 2023–24 and 2024–25

Canopy spread (cm) of elephant foot yam at different growth stages during <i>Kharif-Rabi</i> , 2023–24														
40 DAP					80 DAP					120 DAP				
Treat	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁
B ₀	34.12	36.19	39.07	36.46	45.86	42.51	47.17	45.18	51.16	57.86	64.21	57.74	68.58	69.86
B ₁	42.51	49.55	59.77	50.61	47.95	71.98	79.87	66.60	70.24	89.80	96.86	85.63	78.26	97.62
B ₂	36.76	40.93	50.92	42.87	44.29	60.03	75.35	59.89	58.01	75.45	81.73	71.73	69.91	93.99
B ₃	40.18	47.23	57.45	48.28	47.86	66.33	76.55	63.58	56.81	88.42	93.09	79.44	70.84	96.96
B ₄	37.11	41.87	49.17	42.71	46.87	64.30	71.60	60.92	63.61	72.68	82.32	72.87	69.83	88.27
Mean	38.14	43.15	51.28	44.19	46.57	61.03	70.11	59.24	59.97	76.84	83.64	73.48	71.48	89.34
	F	B	F×B		F	B	F×B		F	B	F×B		F	B
S.E.m±	1.57	2.03	3.52		2.03	2.62	4.54		1.58	2.04	3.53		1.62	2.09
C.D. @ 5%	4.56	5.89	NS		5.88	7.60	13.16		4.58	5.91	10.23		4.68	6.04
Canopy spread (cm) of elephant foot yam at different growth stages during <i>Kharif-Rabi</i> , 2024–25														
40 DAP					80 DAP					120 DAP				
Treat	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁
B ₀	32.61	35.52	42.47	36.87	44.18	47.75	51.43	47.79	58.62	59.68	60.24	59.51	61.31	75.69
B ₁	43.58	48.95	55.17	49.23	51.57	75.55	79.47	68.87	63.68	88.05	95.61	82.45	77.07	97.53
B ₂	38.50	38.66	39.99	39.05	46.52	51.84	55.49	51.28	61.93	68.76	76.75	69.15	63.51	87.62
B ₃	42.93	44.96	46.85	44.91	50.92	69.77	73.78	64.82	63.03	85.06	86.61	78.23	73.33	95.67
B ₄	39.84	39.60	44.90	41.45	49.87	53.40	59.49	54.25	60.94	69.70	78.00	69.55	65.78	91.84
Mean	39.49	41.54	45.88	42.30	48.61	59.66	63.93	57.40	61.64	74.25	79.44	71.78	68.20	89.67
	F	B	F×B		F	B	F×B		F	B	F×B		F	B
S.E.m±	1.45	1.87	3.24		1.19	1.53	2.66		1.62	2.09	3.63		1.35	1.75
C.D. at 5%	4.19	5.41	NS		3.44	4.45	7.70		4.70	6.06	10.50		3.91	5.05

Combined effect of fertilizer levels and biofertilizers

The interaction of fertilizer levels and biofertilizers significantly influenced total dry matter production during both years. The combination of 100% RDF + Azotobacter + PSB (F₂B₁) consistently recorded the highest dry matter accumulation. The superior performance was

due to the synergistic effect of balanced inorganic nutrition along with biological nitrogen fixation and phosphorus solubilization, which improved nutrient uptake, photosynthesis, assimilate translocation, and corm development. Similar findings were reported by Gautam *et al.* (2018) [16] on integrated nutrient management and dry matter accumulation.

Table 4. Total dry matter (Shoot + corm) production (g) of elephant foot yam at different growth stages as influenced by different fertilizer levels with biofertilizers during *Kharif-Rabi*, 2023–24 and 2024–25

Total dry matter (Shoot + corm) production (g) of elephant foot yam during <i>Kharif-Rabi</i> , 2023–24												
Treat	120 DAP				160 DAP				180 DAP			
	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean
B ₀	139.72	147.87	150.76	146.12	211.29	231.08	240.95	227.77	336.79	366.91	376.45	360.05
B ₁	168.30	208.94	215.31	197.52	329.48	378.25	402.29	370.01	454.98	545.75	565.46	522.07
B ₂	144.58	152.36	174.84	157.26	255.81	275.87	287.65	273.11	381.31	401.37	413.15	398.61
B ₃	151.24	167.77	207.58	175.53	291.96	286.56	392.64	323.72	417.46	541.14	545.39	501.33
B ₄	142.00	151.10	154.91	149.34	226.13	254.90	278.90	253.31	374.07	378.29	381.06	377.81
Mean	149.17	165.61	180.68		262.93	285.33	320.49		392.92	446.69	456.30	
	F	B	F×B		F	B	F×B		F	B	F×B	
S.Em±	2.52	3.26	5.64		6.42	8.29	14.35		8.71	11.25	19.43	
C.D. @ 5%	7.31	9.43	16.34		18.59	24.00	41.57		25.24	32.58	56.43	

Total dry matter (Shoot + corm) production (g) of elephant foot yam during <i>Kharif-Rabi</i> , 2024–25												
Treat	120 DAP				160 DAP				180 DAP			
	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean
B ₀	129.22	137.37	140.26	135.62	198.95	226.41	232.62	219.33	324.19	354.31	363.85	347.45
B ₁	167.80	208.44	234.81	203.68	295.82	406.96	431.92	378.23	442.38	573.14	586.19	533.91
B ₂	134.08	161.86	197.67	164.54	240.81	249.32	260.87	250.33	368.71	388.77	400.55	386.01
B ₃	140.74	191.60	217.08	183.14	276.96	357.89	403.64	346.16	411.53	466.79	569.21	482.51
B ₄	131.50	148.04	157.74	145.76	233.57	237.79	239.90	237.09	365.69	394.80	395.13	385.21
Mean	140.67	169.46	189.51		249.22	295.67	313.79		382.50	435.56	462.99	
	F	B	F×B		F	B	F×B		F	B	F×B	
S.Em±	4.12	5.32	9.22		9.21	11.89	20.60		9.50	12.27	21.25	
C.D. at 5%	11.94	15.41	26.70		26.69	34.45	59.67		27.52	35.53	61.54	

Effect of different levels of fertilizer with biofertilizers on single corm weight(g) and yield (t ha⁻¹) of elephant foot yam

2.1 Single corm weight (g)

Effect of fertilizer levels

Different fertilizer levels significantly influenced single corm weight of elephant foot yam. 100% RDF (F₂) recorded the highest corm weight, followed by 75% RDF (F₁), while the control (F₀) recorded the lowest values. The higher corm weight under 100% RDF may be attributed to balanced NPK nutrition, which enhanced photosynthesis, dry matter accumulation, and translocation of assimilates to the developing corm. Similar findings were reported by Biradar *et al.* (2020), Sheeba *et al.* (2017) [17], Biswanath *et al.* (2014) [12], and Choudhary *et al.* (2012).

Effect of biofertilizers

Biofertilizer application significantly increased single corm weight over the control. Azotobacter + PSB (B₁) recorded the highest corm weight and remained at par with *Azospirillum* + PSB (B₃) during

2023–24, while it was significantly superior during 2024–25 and in pooled analysis. The improvement may be due to enhanced biological nitrogen fixation, phosphorus solubilization, better nutrient uptake, and production of growth-promoting substances, which promoted corm development. Treatments involving VAM recorded comparatively lower corm weight because of limited phosphorus availability in lateritic soils. Similar results were reported by Lallawmkima *et al.* (2018) [18] and Nedunchezhiyan *et al.* (2017) [15].

Combined effect of fertilizer levels and biofertilizers

The interaction of fertilizer levels and biofertilizers significantly influenced single corm weight. The combination of 100% RDF + Azotobacter + PSB (F₂B₁) recorded the highest corm weight during both years and in pooled analysis. The superior performance may be attributed to the synergistic effect of balanced inorganic nutrition and beneficial microorganisms, which improved nutrient availability, photosynthesis, dry matter production, and assimilate translocation to the corm, resulting in higher corm weight.

Table 5. Fresh weight of corm (kg/plant) and yield of elephant foot yam tuber (t ha⁻¹) as influenced by different fertilizer levels with biofertilizers during *Kharif-Rabi*, 2023–24 and 2024–25.

Fresh weight of corm of elephant foot yam (kg/plant)												
Treat	<i>Kharif-Rabi</i> 2023-24				<i>Kharif-Rabi</i> 2024-25				Pooled			
	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean

(continued on next page)

Fresh weight of corm of elephant foot yam (kg/plant)												
Kharif- Rabi 2023-24				Kharif- Rabi 2024-25				Pooled				
B ₀	0.40	0.78	0.93	0.71	0.38	0.68	0.80	0.39	0.75	0.88	0.67	0.39
B ₁	0.59	1.32	1.61	1.17	0.56	1.28	1.57	0.57	1.30	1.59	1.16	0.57
B ₂	0.48	1.15	1.19	0.94	0.45	1.06	1.15	0.46	1.11	1.17	0.91	0.46
B ₃	0.57	1.22	1.43	1.07	0.57	1.14	1.35	0.57	1.18	1.39	1.05	0.55
B ₄	0.41	1.01	1.18	0.86	0.43	0.97	1.14	0.42	0.99	1.16	0.86	0.42
Mean	0.49	1.10	1.27		0.48	1.03	1.20		0.73	1.61	1.87	
	F	B	F×B		F	B	F×B		F	B	F×B	
S.Em±	0.03	0.03	0.06		0.02	0.03	0.05			0.02	0.03	0.05
C.D. @ 5%	0.08	0.10	0.17		0.07	0.09	0.16			0.06	0.08	0.13

Yield of elephant foot yam tuber (t ha ⁻¹)												
Kharif- Rabi 2023-24				Kharif- Rabi 2024-25				Pooled				
Treat	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean
B ₀	7.11	13.89	16.62	12.54	6.84	12.73	14.76	11.45	6.98	13.31	15.69	11.99
B ₁	10.52	23.48	28.67	20.89	9.92	22.84	27.84	20.20	10.22	23.16	28.25	20.54
B ₂	8.45	20.45	21.24	16.71	7.98	18.91	20.45	15.78	8.22	19.68	20.85	16.25
B ₃	10.21	21.67	25.45	19.11	10.12	20.25	24.00	18.12	10.16	20.96	24.73	18.62
B ₄	7.31	17.90	20.90	15.37	7.68	17.30	20.23	15.07	7.49	17.60	20.57	15.22
Mean	8.72	19.48	22.58	16.92	8.51	18.41	21.46	16.12	8.61	18.94	22.02	16.52
	F	B	F×B		F	B	F×B		F	B	F×B	
S.Em±	0.48	0.62	1.07		0.45	0.58	1.01		0.36	0.46	0.80	
C.D. at 5%	1.38	1.79	3.10		1.31	1.69	2.93		1.04	1.34	2.33	

F ₀ - No fertilizer	B ₀ - No biofertilizer
F ₁ - 75% RDF	B ₁ - <i>Azotobacter</i> + PSB @ 10 kg/ha each
F ₂ - 100 % RDF	B ₂ - <i>Azotobacter</i> + VAM@ 10 kg/ha each
	B ₃ - <i>Azospirillum</i> + PSB@ 10 kg/ha each
	B ₄ - <i>Azospirillum</i> + VAM @ 10 kg/ha each

2. Yield of elephant foot yam tuber (t ha⁻¹) as influenced by different fertilizer levels with biofertilizers during Kharif-Rabi, 2023–24 and 2024–25

Tuber yield of elephant foot yam was significantly influenced by fertilizer levels, biofertilizer application, and their interaction. Among the fertilizer treatments, 100% RDF (F₂) recorded the highest tuber yield, followed by 75% RDF (F₁), while the control (F₀) produced the lowest yield. The increased yield under 100% RDF may be attributed to the balanced supply of nitrogen, phosphorus, and potassium, which enhanced leaf area development, photosynthetic efficiency, dry matter production, and translocation of assimilates to the developing corm. Similar findings were reported by Biradar *et al.* (2020), Mane (2019), Sheeba *et al.* (2017) [17], Biswanath *et al.* (2014) [12], and Choudhary *et al.* (2012).

Among the biofertilizer treatments, *Azotobacter* + PSB (B₁) recorded the highest tuber yield and remained at par with *Azospirillum* + PSB (B₃) during both years. The superior performance of *Azotobacter* + PSB may be due to enhanced biological nitrogen fixation, phosphorus solubilization, improved nutrient uptake, and production of plant growth-promoting substances, resulting in better corm bulking and higher yield. Similar results were reported by Nedunchezhiyan *et al.* (2017) [15], Lallawmkima *et al.* (2018) [18], and Kadam and Kulkarni (2023).

The interaction of fertilizer levels and biofertilizers also had a significant effect on tuber yield. The combination of 100% RDF + *Azotobacter* + PSB (F₂B₁) consistently recorded the highest yield during both years and in pooled analysis. The synergistic effect of balanced inorganic fertilization and beneficial microorganisms en-

hanced nutrient availability, photosynthesis, dry matter accumulation, and assimilate translocation to the corm, resulting in maximum tuber yield. These findings are in agreement with Kumar *et al.* (2024) [19], who reported higher crop yield under integrated application of RDF and biofertilizers.

Conclusion

The study concluded that the growth of elephant foot yam was significantly influenced by RDF and biofertilizer application. Although sprouting and leaf emergence were not significantly affected, 100% RDF (F₂) consistently produced the highest plant height, canopy spread, and total dry matter production during both years. Among biofertilizer treatments, *Azotobacter* + PSB @ 10 kg ha⁻¹ each (B₁) recorded superior growth performance. The combined application of 100% RDF + *Azotobacter* + PSB (F₂B₁) was the most effective treatment, producing maximum growth and dry matter accumulation, indicating that integrated nutrient management with recommended fertilizer dose and beneficial biofertilizers is the best strategy for enhancing elephant foot yam growth. The corm characteristics and yield of elephant foot yam were significantly improved by different RDF levels and biofertilizer combinations. Application of 100% RDF (F₂) recorded the highest single corm weight, corm ring diameter, corm volume, and corm yield during both years. Among the biofertilizer treatments, *Azotobacter* + PSB @ 10 kg ha⁻¹ each (B₁) consistently produced superior corm growth and yield. The combined application of 100% RDF + *Azotobacter* + PSB (F₂B₁) was the most effective treatment, resulting in maximum corm development and the highest yield, demonstrating that integrated nutrient management with the recommended fertilizer dose and *Azotobacter* + PSB is the best practice for enhancing productivity of elephant foot yam.

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