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Short Communication

Effect of different potting media on the performance of okra (*Abelmoschus esculentus* L. Moench)

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Abstract

The rising demand for high-yielding, space-efficient, and cost-effective agriculture in urban and peri-urban regions has driven interest in optimising lightweight potting media for sustainable cultivation of crops. This study aimed to provide a scientifically proven, lightweight, and affordable potting mixture for the growing of okra (*Abelmoschus esculentus*). The experiment was conducted in a polyhouse at the Banana Research Station, Kerala Agricultural University, across four cropping cycles over two years. The widely recognised Okra variety Anjitha was utilised for the experiment, employing a Completely Randomised Design (CRD) containing 12 treatments with 10 replications for each treatment. The pooled analysis indicated that T9 (195.12 cm) [Soil:Vermiculite:Perlite:Cowdung (2:1:1:2)] made the tallest plants.T11 (23.05 fruits/plant, 39.93g/plant seed yield) [Sand:Vermiculite:Perlite:Cowdung (2:1:1:2)] emerged as the most productive treatment, closely followed by T6 (22.98 fruits/plant, 39.32 g/plant seed yield) [Soil:Sand:Perlite:Cowdung(2:1:1:2)] and T7 (22.70 fruits/plant, 39.20 g/plant seed yield) [Soil:Cocopeat:Vermiculite:Cowdung (2:1:1:2)]. A lightweight medium composed of vermiculite, perlite, and cocopeat reduced the weight of the media while maintaining yield. T7(Cost of media- rupees 10.20/pot) proved to be the most economical choice. These findings demonstrate improved potting media for sustainable okra cultivation.

Keywords: Cocopeat, Container gardening, Okra, perlite, Urban-peri urban, Vermiculite

Okra (*Abelmoschus esculentus* L. Moench), often known as Bhindi, is a widely cultivated vegetable recognised for its considerable nutritional benefits, adaptability, and economic importance. It is abundant in vitamins A, C, and K, as well as dietary fibre and essential minerals, making it a crucial component of diets worldwide. The growing demand for high-yield, space-efficient, and cost-effective agricultural methods in urban and peri-urban areas has resulted in greater interest in optimising lightweight potting media for container cultivation to enhance crop output while ensuring portability.

Potted plants pose two primary barriers to optimal root development. A container environment offers a growth substrate that rapidly becomes saturated during irrigation. Secondly, the limited volume of small containers constrains water storage capacity between irrigation intervals. To keep roots from suffering from lack of oxygen and drought stress, a good growing medium needs to have a structure that keeps the right amount of air and water in it during and between irrigation periods (Fonteno, 1992; Caron and Nkongolo, 1999).Traditional potting medium [Sand: Soil: Cow dung (1:1:1)] may face challenges, including excessive weight, insufficient aeration, inadequate water retention, and nutrient leaching, which can hinder plant growth and productivity. Pot cultivation provides a regulated environment that enhances yield, ensures longevity, and diminishes overall substrate weight, depending upon the selection of suitable potting soil composition. Although there is broad acceptance that materials like vermiculite, perlite, cocopeat, and organic compost improve soil properties, the ideal soil composition for bhindi growth is still uncertain. Research indicates that incorporating perlite into cocopeat improves aeration and water retention (Banitalebi et al., 2021). A comprehensive assessment of several potting media formulations for bhindi, specifically regarding growth performance, yield, and substrate weight reduction, is absent. This study evaluates the impact of 12 distinct potting media formulations on the growth and yield parameters of okra during four crop cycles spanning two years. The primary objective of this investigation is to evaluate the influence of potting media formulations on the growth of okra

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(plant height, leaf count and collar girth), as well as on reproductive indicators (such number of fruits and seed yield). Additionally, the study aims to determine the degree of weight reduction in potting media to improve portability and long-term viability and to identify the best potting mixture for maximising productivity while maintaining light weight and cost-effectiveness. An innovative growing medium is considered advantageous if it yields plants of equal or superior quality compared to those grown on a traditional medium (Bilderback et al., 2013). This research aims to develop a scientifically proven, lightweight, cost-effective, and high-yielding potting mix suitable for sustainable okra cultivation.

The research was carried out in a polyhouse from November 2022 to December 2024. The region exhibits a tropical, humid climate. A Completely Randomised Design (CRD) was employed, comprising 12 treatments with 10 replications for each treatment. The generally accepted okra variety Anjitha was utilised for the investigation. Two okra seeds were planted in 12-inch pots. Pots were filled with 6 litres of 12 different combinations of growing medium. viz., T0 [Soil:Sand:Cowdung(1:1:1)], T1[Soil: Cocopeat: Cowdung (1:1:1)], T2[Soil: Vermiculite:Cowdung (1:1:1)], T3[Soil:Perlite: Cowdung (1:1:1)], T4[Soil:Sand: Cocopeat: Cowdung (2:1:1:2)], T5[Soil:Sand:Vermiculite: Cowdung (2:1:1:2)], T6[Soil:Sand:Perlite:Cowdung (2:1:1:2)], T7[Soil:Cocopeat:Vermiculite:Cowdung (2:1:1:2)], T8[Soil:Cocopeat:Perlite: Cowdung (2:1:1:2)], T9[Soil: Vermiculite:Perlite:Cowdung (2:1:1:2)], T10[Soil:Sand: Cocopeat:Vermiculite:Perlite:Cowdung (4:1:1:1:1:4)] and T11[Sand:Vermiculite:Perlite:Cowdung (2:1:1:2)]. All treatments were managed uniformly following the standard practices outlined in the KAU Package of Practices (POP). A basal treatment of NPK at a rate of 0.90:0.29:0.90 g/pot was applied, succeeded by topdressing with nitrogen at 0.90 g/pot 25 days after sowing (DAS). Additionally, there was a fortnightly topdressing of groundnut cake at a rate of 20 g/ pot.

Foliar application of KAU Sampoorna @ 5g/litre was carried out at 20 days after sowing (DAS) and repeated at 35 DAS.The following seasons I PC 1(I year plant crop 1, November to March 2022-23), I PC 2 (I year plant crop 2, May to September 2023), II PC 1 (II year plant 1, November to March 2023-24), and II PC 2 (II year plant crop 2, May to September 2024) Vegetative parameters were recorded at 90 days after sowing (DAS), while yield parameters, such as the number of fruits per plant and seed yield (g) per plant, were documented at each harvest. The media's physical properties, such as water-holding capacity, bulk density, and porosity, were evaluated before the initiation of the experiment. Chemical properties, including pH, electrical conductivity (EC), and the availability of nitrogen (N), phosphorus (P), and potassium (K), were assessed before and after the experiment. The data collected was analysed with Analysis of Variance (ANOVA) in compliance with a Completely Randomised Design (CRD) including 12 treatments and 10 replications. Statistical analysis was conducted utilising ANOVA, and treatment means were compared using LSD at a 5% significance level in the R program (Gopinath et al., 2020).

Results and Discussion

1. *Influence of potting media on vegetative growth and yield parameters of okra (Var. Anjitha) over four seasons.*

The combination of potting medium significantly affected the vegetative growth and yield parameters of okra (Var. Anjitha) during four seasons, indicating regular patterns. In the pooled analysis, T11 (Sand: Vermiculite: Perlite: Cow dung, 2:1:1:2) consistently yielded the highest number of fruits and seed yield per plant over all four cropping cycles, greatly surpassing other treatments. In I PC 1, T11 exhibited the highest number of fruits per plant (23.00±0.94) and seed yield (40.05±1.43 g per plant), comparable to T6 (Soil: Sand: Perlite: Cow dung, 2:1:1:2) and T7 (Soil: Cocopeat: Vermiculite: Cow dung, 2:1:1:2). Comparable patterns were noted in the following seasons (I PC 2, II PC 1, and II PC 2, illustrating the continuing efficiency of T11 across successive crops. An increased number of fruits is a defining trait of fruit-bearing vegetables, reflecting their productive capacity and serving as a critical indicator of their overall yield potential and yield performance. PCA-Biplot analysis validated the beneficial impact of seed yield-related features, consistently grouping T11, T7, and T6 in the high-yield quadrant during all four seasons. The Scree Plot demonstrated the significance of yield-associated characteristics. The Index Plot constantly positioned T11 at the top of the rankings, succeeded by T7 and T6 so confirming their superior yield performance (Tables 1, 2, 3, 4; Figs. 1, 2, 3, and 4).

These findings align with prior studies indicating that mixed-media surpassed single-component media in promoting the growth and yield of okra and other vegetables,as reported by Fatin et al. (2021) and Swain et al. (2014). Adewole and Ilesanmi (2012) demonstrated analogous findings in okra. The increased productivity in T11, T6, and T7 can be attributed to greater aeration, water retention, and nutrient accessibility resulting from the balanced mixture of perlite, vermiculite, and organic materials. The pooled analysis confirmed the superiority of T11, T7, and T6 in promoting vegetative growth and seed yield parameters, with significant variations noted in plant height, collar girth, fruit quantity, and seed production. T11 (23.05 fruits, 39.93 g seed yield)

Table 1: Vegetative and yield parameters of I PC1

Growing media	Plant height. (cm)	Number of leaves/plant	Collar girth (cm)	Number of fruits/plant	Seed yield (g/plant)
T0	192.33 ± 5.76^{ab}	20.00± 0.67^{def}	5.86 ± 0.25^{g}	20.70± 1.49^{cd}	35.87± 1.59^{bc}
T1	188.67 ± 2.72^{bcd}	20.30±0.48^{cde}	5.98 ± 0.13^{fg}	21.10± 0.74^{cd}	36.34 ± 1.39^{b}
T2	187.18±2.68^{cde}	20.00± 1.05^{def}	6.29± 0.21^{cde}	21.30 ± 0.95^{c}	35.16 ± 1.36^{c}
T3	185.08 ± 3.10^{de}	19.60± 1.43^{ef}	6.42± 0.38^{abc}	20.00 ± 1.56^{d}	35.76± 1.58^{bc}
T4	184.80 ± 2.44^{e}	19.10± 0.99^{f}	5.90 ± 0.25^{g}	20.00 ± 1.05^{d}	36.14± 1.01^{bc}
T5	189.28 ± 6.04^{bc}	19.90±1.60^{def}	6.22 ± 0.21^{cde}	20.90 ± 1.45^{cd}	36.72 ± 1.04^{b}
T6	189.83 ± 2.91^{abc}	20.80±0.42^{bcd}	6.36 ± 0.14^{bcd}	22.90 ± 0.74^{a}	39.53 ± 1.56^{a}
T7	189.24 ± 3.72^{bc}	21.30±0.67^{ab}	6.56 ± 0.20^{ab}	22.60 ± 1.07^{ab}	39.94 ± 0.84^{a}
T8	188.80 ± 3.80^{bc}	21.50±0.85^{ab}	6.13 ± 0.51^{ef}	21.20 ± 2.20^{c}	36.44 ± 1.13^{b}
T9	193.42 ± 4.69^{a}	21.20±1.32^{abc}	6.27 ± 0.15^{cde}	21.60 ± 1.26^{bc}	36.59 ± 0.91^{b}
T10	192.06 ± 6.65^{ab}	21.30±0.95^{ab}	6.16 ± 0.14^{def}	21.70 ± 1.25^{bc}	35.96± 0.87^{bc}
T11	187.86 ± 2.26^{cde}	22.00± 1.05^{a}	6.61 ± 0.19^{a}	23.00 ± 0.94^{a}	40.05 ± 1.43^{a}
F stat	4.12**	7.61**	9.05**	6.12**	19.20**
p value	0.00	0.00	0.00	0.00	0.00
CD	3.69	0.9	0.22	1.14	1.11
SE(m)	1.32	0.32	0.08	0.41	0.40
CV(%)	2.20	4.95	4.05	6.02	3.39
Cohen's F	0.65	0.88	0.96	0.79	1.40

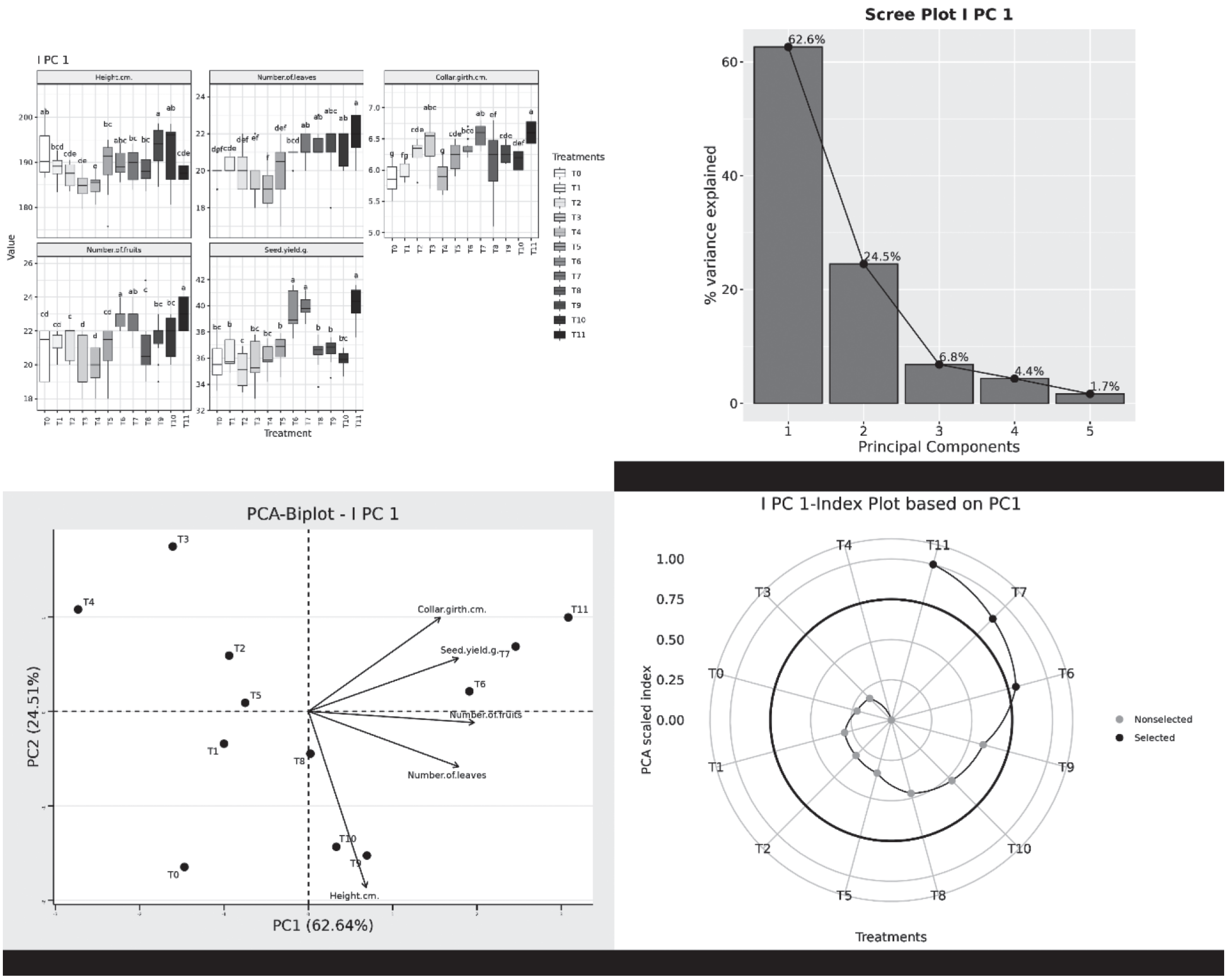

Figure 1 - Box plot, Scree plot PCA - Biplot, and Index plot based on scaled index score - I PC 1

Table 2. Vegetative and yield parameters of I PC2

Growing media	Plant Height (cm)	No..of.leaves//plant	Collar girth (cm)	No.of fruits/plant	Seed yield (g/plant)
T0	194.39± 6.04	19.50 ±0.85^{cd}	5.97 ±0.09^{ef}	20.80±0.42^{cde}	35.16±1.07^{de}
T1	190.61± 6.52	19.20 ± 1.03^{d}	5.90 ± 0.08^{f}	20.90±0.32^{cde}	35.49±0.87^{cd}
T2	189.27 ± 4.89	20.00±1.05^{bcd}	6.41 ± 0.31^{bc}	21.50 ± 0.53^{c}	35.12±0.99^{de}
T3	188.08 ± 6.73	19.90±1.45^{bcd}	6.29 ± 0.24^{cd}	19.70 ± 1.25^{f}	35.29±1.01^{de}
T4	187.85 ± 6.96	19.30 ±1.34^{cd}	5.93 ± 0.27^{f}	20.30 ±1.06^{ef}	35.71±0.91^{cd}
T5	192.28 ± 9.99	20.10±1.60^{bcd}	6.27 ± 0.41^{cd}	20.40±1.17^{def}	35.55±1.60^{cd}
T6	190.95 ± 6.49	20.50 ±1.96^{bc}	6.37 ± 0.09^{c}	23.10 ±0.32^{ab}	38.83±1.22^{b}
T7	191.99 ± 5.61	21.00 ±0.94^{ab}	6.73 ± 0.26^{a}	22.60 ± 1.65^{b}	38.58±0.73^{b}
T8	191.01 ± 8.59	20.90 ±2.33^{ab}	6.22 ± 0.51^{cde}	20.90±0.32^{cde}	35.35 ±0.55^{de}
T9	197.05 ± 8.37	21.90 ± 0.99^{a}	6.04 ± 0.28^{def}	21.00±0.00^{cde}	36.42 ± 0.74^{c}
T10	195.14 ± 6.04	19.80±0.79^{bcd}	6.39 ± 0.44^{c}	21.10 ± .32^{cd}	34.47 ± 1.84^{e}
T11	192.55 ± 5.84	21.80 ± 1.03^{a}	6.67 ± 0.26^{ab}	23.60 ± 0.52^{a}	39.80 ± 0.60^{a}
F stat	1.58^{NS}	4.47**	8.28**	21.16**	26.17**
p value	0.11	0.00	0.00	0.00	0.00
CD	-	1.2	0.27	0.72	0.96
MSE	48.71	1.85	0.09	0.66	1.16
SE(m)	2.21	0.43	0.09	0.26	0.34
SE(d)	3.12	0.61	0.13	0.36	0.48
CV(%)	3.64	6.69	4.77	3.80	2.97
Cohen's F	0.40	0.67	0.92	1.47	1.63

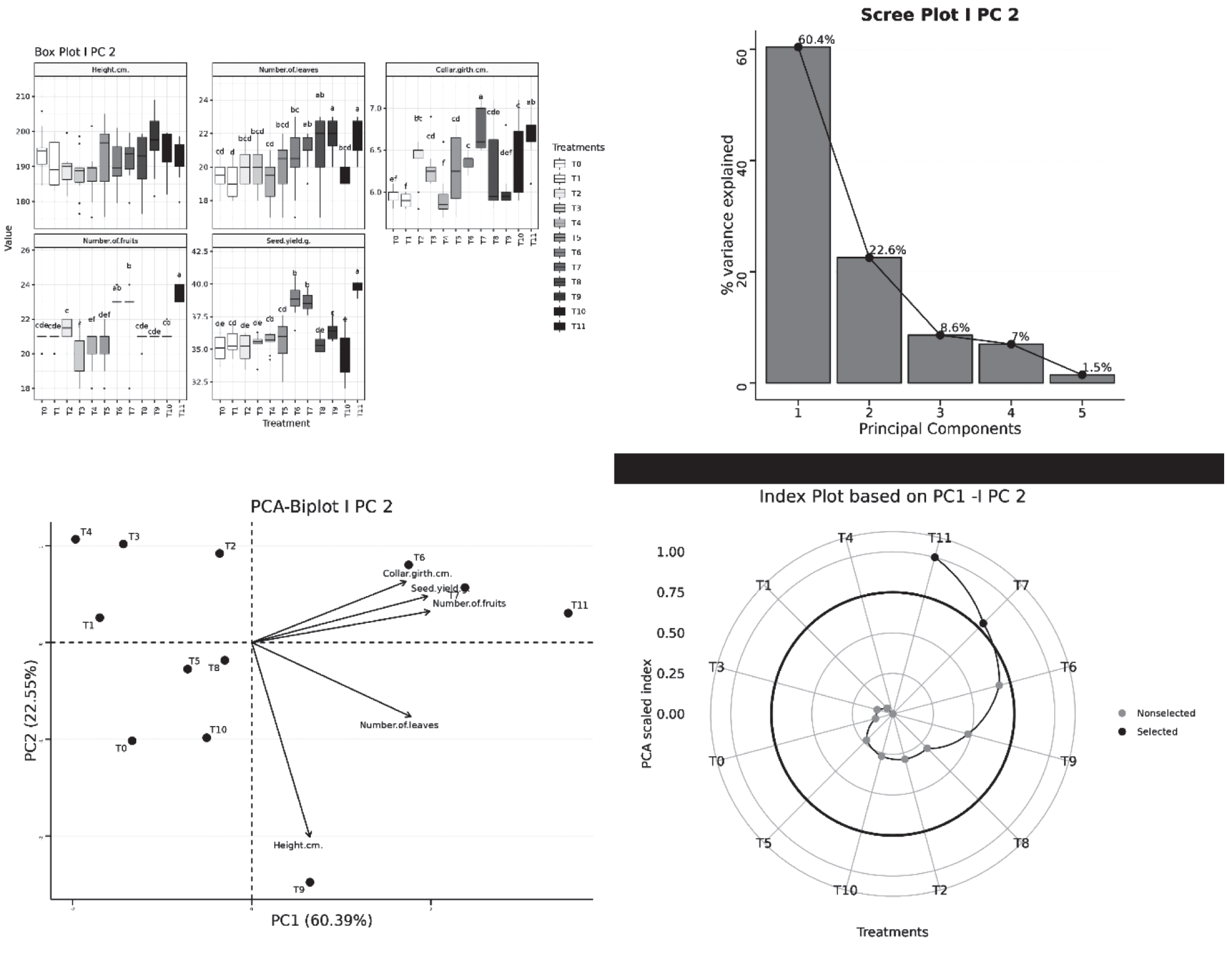

Figure 2. Box plot, Scree plot PCA Biplot, and Index plot based on scaled index score - I PC 2

Table 3. Vegetative and yield parameters of II PC 1

Growing media	Plant Height (cm)	No of leaves/plant	Collar girth (cm)	No. of fruits/plant	Seed Yield (g/plant)
T0	192.31±5.42	19.20 ± 0.63^{d}	5.94 ± 0.10^{d}	20.70±0.48^{bc}	35.56 ±1.20^{d}
T1	188.50±5.54	19.20 ± 1.03^{d}	5.90 ± 0.08^{d}	20.50 ±0.53^{bc}	35.54 ±0.89^{d}
T2	187.79±4.39	18.90 ± 0.88^{d}	6.41 ±0.31^{bc}	21.40 ± 0.97^{b}	35.53 ±0.78^{d}
T3	188.37±6.62	18.80 ± 1.14^{d}	6.25 ± 0.14^{c}	20.30 ± 1.06^{c}	35.70±1.39^{bcd}
T4	187.73±6.90	19.10 ± 1.37^{d}	5.93 ±0.27^{d}	20.30 ± 1.06^{c}	35.91±1.20^{bcd}
T5	188.79±7.68	20.00 ± 1.49^{cd}	6.35 ± 0.36^{c}	20.30 ± 1.16^{c}	35.86±1.13^{bcd}
T6	189.43±6.36	20.50±1.96^{bc}	6.45±0.21^{bc}	22.60 ± 1.35^{a}	39.37 ± 1.13^{a}
T7	189.91±5.42	22.10 ± 1.20^{a}	6.79 ± 0.27^{a}	22.80 ± 1.75^{a}	38.93 ± 0.79^{a}
T8	188.86±8.43	21.30 ± 2.50^{ab}	6.25 ± 0.49^{c}	21.20 ±1.93^{bc}	36.62 ±1.51^{bc}
T9	195.14±6.51	22.10 ± 0.99^{a}	6.28 ± 0.41^{c}	20.80 ±0.79^{bc}	36.70 ± 0.58^{b}
T10	190.59±6.80	21.00±1.56^{abc}	6.25 ± 0.27^{c}	20.80 ±0.63^{bc}	35.65 ±1.75^{cd}
T11	190.86±5.44	21.80 ± 1.03^{a}	6.64 ±0.21^{ab}	22.60 ± 0.84^{a}	39.91 ± 0.73^{a}
F stat	1.13^{NS}	8.50**	9.30**	7.10**	20.84**
p-value	0.35	0.00	0.00	0.00	0.00
CD	NS	1.24	0.25	1	1.01
MSE	40.75	1.97	0.08	1.28	1.30
SE(m)	2.02	0.44	0.09	0.36	0.36
CV(%)	3.36	6.90	4.52	5.34	3.10
Cohen's F	0.34	0.93	0.97	0.85	1.46

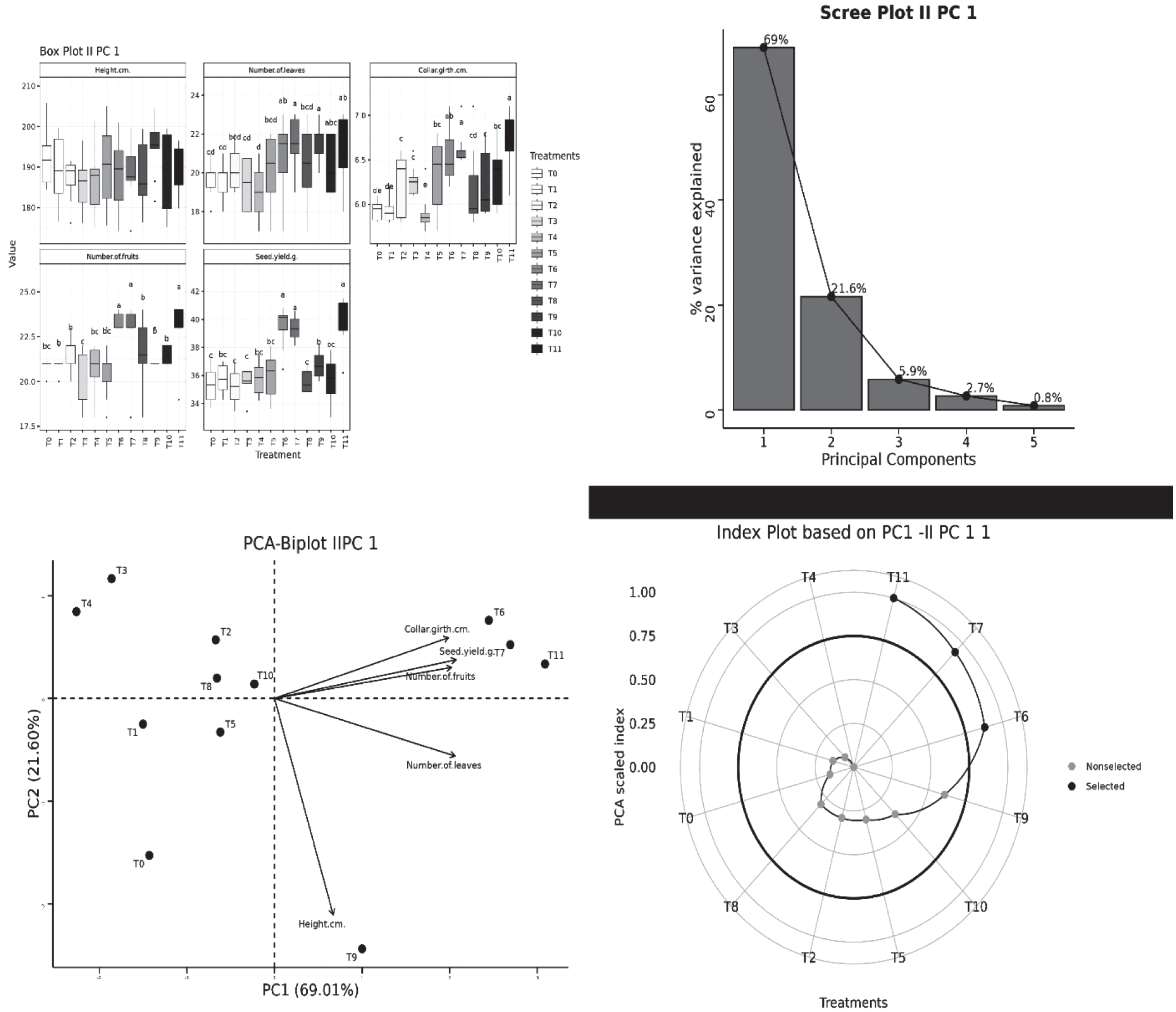

Figure3. Box plot, scree plot, PCA – Biplot and index plot based on Scaled index score - II PC 1

Table 4. Vegetative and yield parameters of II PC 2

	Plant height (cm)	No. of leaves/plant	Collar girth cm.	No. of fruits/plant	Seed yield (g/plant)
T0	192.31±5.42	19.20 ± 0.63^{d}	5.94 ± 0.10^{d}	20.70 ± 0.48^{bc}	35.56±1.20^{d}
T1	188.50±5.54	19.20±1.03^{d}	5.90 ± 0.08^{d}	20.50 ± 0.53^{bc}	35.54±0.89^{d}
T2	187.79±4.39	18.90± 0.88^{d}	6.41 ± 0.31^{bc}	21.40 ± 0.97^{b}	35.53±0.78^{d}
T3	188.37±6.62	18.80± 1.14^{d}	6.25 ± 0.14^{c}	20.30 ± 1.06^{c}	35.70±1.39^{bcd}
T4	187.73±6.90	19.10± 1.37^{d}	5.93 ± 0.27^{d}	20.30 ± 1.06^{c}	35.91±1.20^{bcd}
T5	188.79±7.68	20.00± 1.49^{cd}	6.35 ± 0.36^{c}	20.30 ± 1.16^{c}	35.86±1.13^{bcd}
T6	189.43±6.36	20.50± 1.96^{bc}	6.45 ± 0.21^{bc}	22.60 ± 1.35^{a}	39.37±1.13^{a}
T7	189.91± 5.42	22.10 ± 1.20^{a}	6.79 ± 0.27^{a}	22.80 ± 1.75^{a}	38.93± 0.79^{a}
T8	188.86± 8.43	21.30 ± 2.50^{ab}	6.25 ± 0.49^{c}	21.20 ± 1.93^{bc}	36.62 ± 1.51^{bc}
T9	195.14± 6.51	22.10 ± 0.99^{a}	6.28 ± 0.41^{c}	20.80 ± 0.79^{bc}	36.70 ± 0.58^{b}
T10	190.59± 6.80	21.00 ± 1.56^{abc}	6.25 ± 0.27^{c}	20.80 ± 0.63^{bc}	35.65 ± 1.75^{cd}
T11	190.86± 5.44	21.80 ± 1.03^{a}	6.64 ± 0.21^{ab}	22.60 ± 0.84^{a}	39.91 ± 0.73^{a}
F stat	1.13^{NS}	8.50**	9.30**	7.10**	20.84**
p value	0.35	0.00	0.00	0.00	0.00
CD	NS	1.24	0.25	1	1.01
MSE	40.75	1.97	0.08	1.28	1.30
SE(m)	2.02	0.44	0.09	0.36	0.36
SE(d)	2.85	0.63	0.13	0.51	0.51
CV(5%)	3.36	6.90	4.52	5.34	3.10
Cohen's F	0.34	0.93	0.97	0.85	1.46

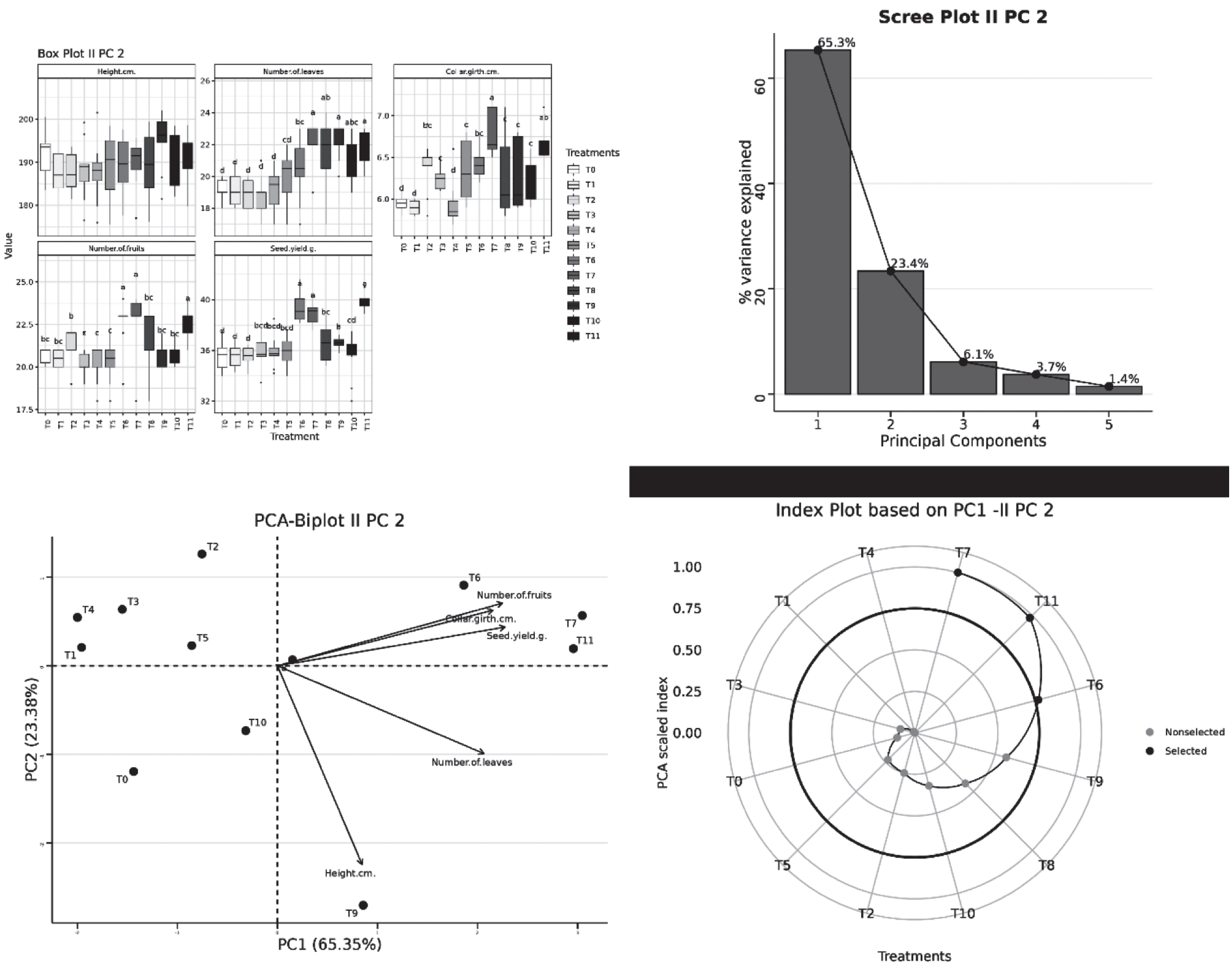

Figure 4. Box plot, Scree plot, PCA – Biplot and index plot based on index scaled score - II PC 2

Table 5. Vegetative and yield parameters of four crop pooled analysis

Treatment	Plant height (m)	Collar girth (cm)	Leaves/ plant	Number of fruits/ plant	Seed yield (g/plant)
T0	192.65	5.94	19.58	20.70	35.44
T1	189.21	5.93	19.58	20.90	35.78
T2	187.82	6.34	19.78	21.45	35.25
T3	186.62	6.30	19.43	19.95	35.50
T4	186.61	5.91	19.15	20.33	35.88
T5	190.01	6.29	20.05	20.55	36.01
T6	189.66	6.43	20.70	22.98	39.32
T7	189.94	6.68	21.50	22.70	39.20
T8	189.13	6.19	21.00	21.20	35.99
T9	195.12	6.21	21.70	21.20	36.62
T10	191.56	6.28	20.63	21.25	35.46
T11	190.28	6.66	21.75	23.05	39.93
P-value	0.00	0.51	0.00	0.00	0.28
LSD at 5%	0.29	0.10	0.48	0.56	0.41
CV%	2.04	3.66	6.69	0.62	0.25

consistently outperformed other treatments in all parameters, with T6 and T7 closely following. Table 5. The results highlight the advantageous impact of enhanced potting mixtures in optimising yield potential, consistent with the observations of Acharya et al. (2024) in okra and Subramani et al. (2020) in tomato .

2. *Impact of Chemical Properties on Nutrient Accessibility and Yield, emphasising on Nitrogen (N), Phosphorus (P), and Potassium (K)*

The chemical properties of the growth medium changed over the cropping cycles, affecting nutrient availability and production. The media pH experienced a minor reduction following cropping, decreasing from 7.17 to 6.26 in T11. Optimal pH levels (6.26 in T11) enhance nutritional absorption, as documented in prior studies by Zhang et al. (2025) and Läuchli et al. (2017). Electrical conductivity directly influences nutrient absorption. A reduction in electrical conductivity (EC) stimulates nutrient uptake. In T11, a large decrease(0.81 dS/m to 0.39 dS/m) in EC improves productivity.

This validates results from Torres et al. (2022), who observed that EC dynamics affect okra's nutrient absorption and availability. The availability of nitrogen rose in T1 and T7 as a result of enhanced mineralisation from organic amendments, including cow dung, groundnut cake, and cocopeat. Conversely, T11 and T9 exhibited a reduction in nitrogen availability attributable to efficient nitrogen absorption for fruit and seed development. This pattern aligns with the findings of Nemati et al. (2015), who observed that efficient nitrogen cycling and nutrient uptake are characteristic of balanced potting media.

Phosphorus availability increased in the majority of treatments due to phosphorus mineralisation and an optimum pH, with T5 and T7 exhibiting the most pronounced increases. In high-yielding T11, phosphorus concentrations significantly diminished, signifying efficient phosphorus utilisation for reproductive development. Potassium levels diminished across all treatments, indicating significant absorption during fruiting and seed development. T9 demonstrated the most substantial reduction, along with its elevated fruit production. In contrast, T11 sustained moderate potassium levels despite elevated productivity, indicating effective nutrient recycling and balanced absorption. Comparable patterns were documented by Nemati et al. (2015).

Bulk density (g/cm³), porosity (%), and water retention capacity (%) are the attributes that determine the physical properties of the growing medium. The physical properties of twelve unique potting medium formulations (T0–T11) were examined in terms of bulk density (BD), porosity, and water-holding capacity (WHC). These variables are crucial in evaluating the media's suitability for plant development. Bulk density varied from 0.66 g/cm³ (T7) to 1.17 g/cm³ (T11). A lower bulk density (BD) signifies a well-aerated medium, while a larger BD suggests compaction, potentially obstructing root development. The lowest bulk density values were observed in T7 (0.66 g/cm³), T3 (0.68 g/cm³), and T5 (0.68 g/cm³), making them possibly more favourable for root penetration and aeration. Porosity, which influences aeration and drainage, demonstrated significant variance among treatments, ranging from 39.5% (T0) to 69.3% (T8). The highest porosity was recorded in T8 (69.3%) and T4 (65.0%), indicating air space for root respiration. The water-holding capacity differs based on the kinds and sizes of the components in the growing medium(Sahoo et al., 2023). WHC is a crucial indicator of a medium's ability to retain moisture, influencing plant hydration. The highest water holding capacity (WHC) values were observed in T9 (88.9%), T7 (86.6%), and T3 (84.6%), demonstrating their superior moisture retention capacities. Table 6.

Table 6. Physical properties of growing medium

Growing medium	Bulk density (g/cm³)	Porosity (%)	Water holding capacity (%)
T0	1.13	39.5	33.4
T1	0.84	40.1	52.6
T2	0.83	56.0	77.8
T3	0.68	54.8	84.6
T4	1.08	65.0	64.1
T5	0.68	52.5	78.0
T6	1.12	45.3	39.2
T7	0.66	51.2	86.6
T8	0.93	69.3	74.3
T9	0.72	56.6	88.9
T10	0.99	54.2	63.0
T11	1.17	46.3	45.0

Table 7. Chemical properties of the growing medium before the experiment

Growing media	pH	EC (dS/m)	Available Nitrogen (%)	Available Phosphorus (%)	Available Potassium (%)
T0	6.6	0.45	0.13	0.13	0.08
T1	6.03	1.3	0.27	0.41	0.19
T2	6.83	0.81	1.41	0.32	0.55
T3	6.73	0.54	0.54	0.31	0.18
T4	6.77	0.60	0.27	0.19	0.08
T5	6.8	0.61	0.20	0.23	0.10
T6	6.84	0.61	0.13	0.18	0.20
T7	6.68	0.51	0.27	0.40	0.52
T8	6.27	0.91	0.34	0.54	0.25
T9	6.81	0.68	0.27	0.29	0.70
T10	6.55	0.24	0.54	0.31	0.33
T11	7.17	0.81	0.27	0.31	0.48

Table 8. Chemical properties of growing medium after two crops in the experiment

Growing media	pH	EC (dS/m)	Available Nitrogen (%)	Available Phosphorus (%)	Available Potassium (%)
T0	6.01	0.35	0.60	0.27	0.17
T1	6.04	0.48	1.48	0.33	0.37
T2	6.39	0.48	1.08	0.37	0.37
T3	6.38	0.41	1.34	0.27	0.33
T4	6.21	0.57	0.81	0.42	0.34
T5	6.47	0.36	0.94	0.47	0.46
T6	6.34	0.45	0.94	0.36	0.33
T7	6.01	0.56	1.14	0.47	0.42
T8	6.16	0.56	1.28	0.36	0.35
T9	6.18	0.43	0.67	0.47	0.37
T10	6.23	0.43	0.87	0.41	0.36
T11	6.26	0.39	0.54	0.21	0.35

3. *Economic feasibility and portability of potting media combinations*

The assessment of economic viability and portability indicated significant variations in productivity, cost-effectiveness, and portability among the 12 potting combinations. T11 (23.05 fruits, 39.93 g seed yield/plant) and T6 (22.98 fruits, 39.32 g seed yield) had the highest fruit count per plant and seed yield. Despite T11 and T6 being slightly more costly (T11: Rs. 22.12, T6: Rs. 19.20), the enhanced seed yield justifies the investment. T7 (22.70 fruits, 39.20 g seed yield/plant) emerged as the most affordable option, demonstrating substantial output at a lower cost (Rs. 10.20), thereby achieving the ideal balance between cost and seed yield.

The findings suggested that investing in slightly costlier yet nutrient-balanced growing materials maximises yield potential and profitability. The assessment of weight and portability indicated that lighter potting mediums, namely T1 (3.16 kg) and T8 (3.22 kg), are better suited for urban gardening and container farming due to their ease of handling. Conversely, denser mixtures like T0 (6.52 kg) are less practical for ease in shifting but may be suitable for stationary farming systems. Due to its superior cost-efficiency, which balanced affordability, yield, and portability, T7 (3.77 kg) was deemed suitable for commercialisation. T6 (4.90 kg) and T11 (4.91 kg) exhibited the maximum number of fruits per plant and seed yield; hence, their moderate weight and relatively high cost effectively balanced portability and yield.

A combination of growing media proved to be a viable alternative to conventional potting mixtures, offering the added advantage of being lightweight and easy to handle, a conclusion that aligns with the observations of Shankar et al. (2024) in marigold, and the growing medium they used consists of Cocopeat (40%) + soil (20%) +FYM (20%) + vermiculite (10%)+rice husk (10%) in African marigold var. 'Double Orange'. T7 was the most cost-effective option overall, highlighting the importance of nutrient-balanced growing material for maximum production. This approach is consistent with the observations of Gupta et al. (2023) and Singh et al. (2020), both of whom highlighted the significance of nutrient-balanced growing media in

Table 9. Components, quantity and cost details of growing medium

Growing media	Components of media	Quantity of each media component	Weight of growing media per pot (kg)	Cost of growing media per pot (Rs.)
T0	Soil +Sand+ Cowdung (1:1:1)	Soil(2.52 kg), Sand (3.6kg), Cow dung(0.40 kg)	6.52	3.2
T1	Soil+Cocopeat+Cowdung (1:1:1)	Soil(2.52 kg), Cocopeat(0.24kg), Cow dung (0.40kg)	3.16	11.36
T2	Soil+Vermiculite+Cowdung (1:1:1)	Soil(2.52 kg), Vermiculite(1.46 kg), Cowdung (0.40kg)	4.38	9.04
T3	Soil+Perlite+Cowdung (1:1:1)	Soil(2.52 kg), Perlite (0.36kg), Cowdung (0.40 kg)	3.28	35.6
T4	Soil+Sand +Coirpith+ Cowdung (2:1:1:2)	Soil(2.52 kg), Sand (1.8kg)cocopeat (0.12 kg), Cowdung (0.4 kg)	4.84	7.28
T5	Soil + Sand +Vermiculite + Cowdung (2:1:1:2)	Soil(2.52 kg), Sand (1.8kg), Vermiculite (0.73 kg), Cowdung (0.40 kg)	5.45	5.12
T6	Soil + Sand + Perlite + Cowdung (2:1:1:2)	Soil(2.52 kg), Sand (1.8kg), Perlite (0.18 kg),Cowdung (0.40kg)	4.9	19.2
T7	Soil + Coirpith + Vermiculite + Cowdung (2:1:1:2)	Soil(2.52 kg), Cocopeat (0.12 kg), Vermiculite (0.73 kg), Cowdung (0.40kg)	3.77	10.2
T8	Soil + Coirpith + Perlite +Cowdung (2:1:1:2)	Soil(2.52 kg), Cocopeat (0.12 kg), Perlite (0.18 kg), Cowdung (0.40kg)	3.22	23.28
T9	Soil + Vermiculite + Perlite + Cowdung (2:1:1:2)	Soil(2.52 kg), Vermiculite (0.73 kg), Perlite (0.18) , Cowdung(0.40 kg)	3.88	22.12
T10	Soil+ Sand +Coirpith +Vermiculite + Perlite + Cowdung(4:1:1:1:1:4)	Soil (5.04 kg), Sand(1.8 kg), Cocopeat (0.12 kg), Vermiculite (0.73 kg), Perlite (0.18), Cowdung (0.8 kg)	4.33	29.40
T11	Sand + Vermiculite+ Perlite +Cowdung (2:1:1:2)	Sand(3.6 kg),Vermiculite (0.73kg),), Perlite (0.18) , Cowdung(0.40 kg)	4.91	22.12

promoting sustainable vegetable production and supporting effective agricultural practices.

Conclusion

This study demonstrated that the choice of potting media have substantially influenced the vegetative growth and yield metrics of okra (var. Anjitha), with T11 (Sand: Vermiculite: Perlite: Cow dung, 2:1:1:2), T6 (Soil: Sand: Perlite: Cow dung, 2:1:1:2), and T7 (Soil: Cocopeat: Vermiculite: Cow dung, 2:1:1:2) consistently outperforming other treatments across the four cropping cycles. The improved effectiveness of these combinations is due to their balanced nutrient composition, excellent aeration, and water retention properties, which facilitated efficient nutrient uptake and absorption. The pooled research determined that T11 produced the highest number of fruits and seed yield per plant, with T6 and T7 ranking next.

Economic analysis indicated that T11 and T6, albeit with slightly higher expenses, exhibited the greatest fruits and seed yield potential and profitability. T7 was the most economical, harmonising production, expense, and portability, rendering it ideal for commercial and urban horticulture. The strategic application of perlite, vermiculite, and organic amendments enhanced sustainability. Nutrient-balanced potting mixtures are necessary to optimise okra productivity, economic efficiency, and environmental sustainability. Future research should investigate the long-term impacts of these potting mediums on soil health and production across various environmental conditions, as well as their application in other fruit and vegetable crops

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