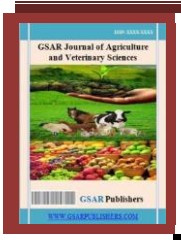

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EVALUATION OF SUBSTRATE COMPOSITION ON CUCUMBER (*Cucumis sativus* L.) GROWTH AND YIELD

By

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Abstract

This study aimed to evaluate the effects of different planting medium compositions on the growth and yield of cucumber (Cucumis sativus L.). The experiment was conducted from February 3 to March 27, 2023, in Bajulan Hamlet, Ngampel Village, Papar District, Kediri Regency, East Java Province. A one-factor Completely Randomized Design (CRD) was utilized, comprising seven treatment levels based on varying compositions of soil, goat manure, and chicken manure (measured in kilograms), with four replications per treatment. Each replication consisted of two polybags (duplo), resulting in a total of 56 experimental units. Non-destructive observations included measurements of plant length (cm), number of leaves, and number of branches. Yield-related parameters assessed were fruit length (cm), fruit diameter (cm), number of fruits per plant, and fruit weight per plant (g). The data were analyzed using Analysis of Variance (ANOVA), followed by the Least Significant Difference (LSD) test to determine treatment effects. The results indicated that the composition of the planting medium had a statistically significant influence on both vegetative growth and yield components of cucumber. Specifically, plant height, leaf number, branch number, fruit length, fruit diameter, fruit count, and fruit weight were all significantly affected. The most optimal performance was achieved in the treatment with a balanced mixture of 2 kg soil, 2 kg goat manure, and 2 kg chicken manure (designated as Treatment K1).

Index Terms- *growing media; manure; organic; substrate*

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a widely cultivated vegetable substantial global popularity. Its cultivation has expanded across various tropical and subtropical regions, although its origin traces back to the highlands of the Himalayas (Irfan, Dalimunthe, & Saragih, 2020). Cucumber is known for its health benefits, as well as a natural skin treatment. Per 100 g of cucumber contains 0.01 mg riboflavin, 0.3 mg vitamin B1, 3 g carbohydrates, 0.8 g protein, 0.3 mg vitamin A, 0.5 mg iron, 30 mg phosphorus, 14 mg ascorbic acid (vitamin C), 15 calories, 0.02 mg thiamine, and 0.02 mg vitamin B2 (Febriani, Darmawati, & Fuskhah, 2021).

In addition to its nutritional richness, cucumber has considerable potential as a commercial crop, with markets extending both domestically and internationally. However, according to data from the Indonesian Central Statistics Agency (Badan Pusat Statistik, 2019), cucumber production in Indonesia has exhibited a consistent decline over several years from 491,636 tons in 2013 to 477,989 tons in 2014, 447,696 tons in 2015, 430,218 tons in 2016, and 424,917 tons in 2017.

The decline in cucumber productivity can be attributed to several factors, including genetic limitations, climatic or environmental conditions, and suboptimal cultivation techniques such as soil preparation, weeding, irrigation, fertilization, and pest and disease control. Moreover, the low productivity is also linked to the fact that many farmers treat cucumber cultivation as a secondary or supplementary enterprise rather than a primary source of income (Khoirunnisa, Fuskhah, & Widjajanto, 2019).

Organic matter is a crucial component in sustainable agricultural practices. Organic fertilizers play a significant role in improving soil quality (chemically, biologically, and physically) by increasing soil carbon content (Hijria & Syarni, 2018). Among various organic fertilizers, goat and poultry manure have proven particularly beneficial for cucumber cultivation. Goat manure improves soil aeration, enhances nutrient retention and water-holding capacity, stabilizes soil structure, supports soil microbial activity, and serves as a nutrient source (Dewi, 2018). Meanwhile, poultry manure contributes to enriching soil nutrient content, increasing nutrient availability in organic-deficient soils, and supplying

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additional nutrients for plant growth (Walida & Harahap, 2020).

Given the importance of organic input in enhancing soil fertility and promoting sustainable crop productivity, the selection and composition of organic media become critical factors influencing plant growth and yield performance. Differences in the physical and chemical properties of goat and poultry manure may result in varied effects on cucumber growth parameters and fruit production. Therefore, it is essential to evaluate how different combinations of these organic materials within the planting medium affect cucumber performance under controlled cultivation conditions. Accordingly, this study aims to assess the influence of planting media composition on the growth and yield of cucumber plants.

RESEARCH ELABORATIONS

The experiment was conducted in Ngampel Village, Papar District, Kediri Regency, East Java, Indonesia, geographically located at coordinates -7.768271° S and 112.052178° E. The research took place over a period of approximately two months, from February 3 to March 27, 2023. The site represents typical lowland tropical agroecosystem with warm temperatures and moderate rainfall, which are favorable conditions for cucumber (*Cucumis sativus* L.) cultivation.

The materials used in this study included cucumber seeds (*Cucumis sativus* L.), planting media consisting of soil, goat manure, and poultry manure, and polybags serving as planting containers. Several supporting tools were employed during the research process, such as a digital scale to measure the weight of materials and harvests, a ruler to measure plant height, a caliper to determine fruit diameter, and a hand trowel for mixing planting media and filling polybags. Data were systematically recorded on field log sheets to ensure the accuracy and traceability of all observations.

The experimental design followed a Completely Randomized Design (CRD) with a single non-factorial treatment factor—namely, the variation in planting media composition. Seven treatment combinations were formulated based on the proportions (by weight) of soil, goat manure, and poultry manure, as follows:

K1 (2:2:2), K2 (3:2:1), K3 (3:1:2), K4 (1:3:2), K5 (1:2:3), K6 (3:3:0), and K7 (3:0:3). Each treatment was replicated four times, and each replication consisted of two polybags (duplo), resulting in a total of 56 experimental units.

Table 1. Composition of Planting Media Treatments

Treatment Code	Soil (kg)	Goat Manure (kg)	Poultry Manure (kg)
K1	2	2	2
K2	3	2	1
K3	3	1	2
K4	1	3	2
K5	1	2	3
K6	3	3	0
K7	3	0	3

Observations were carried out on both non-destructive growth parameters. The non-destructive growth parameters included plant height (cm), number of leaves, and number of branches, while the destructive parameters comprised fruit length (cm), fruit diameter (cm), number of fruits per plant, and fruit weight per plant (g).

All data collected were subjected to statistical analysis using Analysis of Variance (ANOVA) to determine the significance of treatment effects on the observed variables. When significant or highly significant differences were detected, the analysis was followed by a Least Significant Difference (LSD) test at a 5% significance level to identify specific differences among treatment means. This analytical approach ensured robust interpretation of treatment effects and reliable conclusions regarding the optimal composition of organic planting media for cucumber cultivation.

RESEARCH FINDINGS

Plant height was observed as one of the key indicators of vegetative growth in cucumber, as it reflects the plant's response to nutrient availability and overall growing conditions. Variations in planting media composition, particularly in the proportions of soil, goat manure, and poultry manure, were expected to influence the rate of vegetative development. Measurements of plant height were conducted periodically at 7, 14, and 21 days after sowing (DAS) to assess the growth dynamics of cucumber plants under different treatment conditions. The average plant heights for each treatment are presented in Table 2.

Table 2. Average Plant Height (cm) of Cucumber Under Different Planting Media Compositions

Treatment	Average Plant Height		
	7 DAS	14 DAS	21 DAS
K1	12.00	28.50	96.25b
K2	12.75	32.00	105.25b
K3	12.50	30.75	95.25b
K4	12.50	28.25	91.00b
K5	13.25	30.75	90.50b
K6	12.50	21.50	62.50a
K7	13.25	29.75	89.00b
LSD 5%	ns	ns	24.05

Note: Means followed by the same letter within a column are not significantly different according to 5% LSD test.
Source: Primary Data Analysis (2025)

The results presented in Table 2 demonstrate the influence of planting media composition on cucumber plant height at three

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observation periods. During the early stages of growth (7 and 14 DAS), the results showed no significant difference among treatments, as indicated by "ns" (not significant) result of the ANOVA test. This suggests that, at the seedling stage, cucumber plants exhibit similar growth responses regardless of variations in the media composition. Results also indicate that planting media compositions lacking poultry manure resulted in lower average cucumber plant height at 21 days after sowing (DAS).

The lower plant height values are presumed to be related to limited nutrient availability, particularly nitrogen (N) and phosphorus (P), which are naturally more abundant in poultry manure than in goat or cattle manure. While goat manure is relatively stable and does not excessively increase the temperature of the growing medium, the absence of nitrogen-rich components from poultry manure may inhibit vegetative growth, especially stem elongation.

Although the thermal characteristics of poultry manure often raise concerns due to their potential to disrupt root development or induce plant stress, the present study suggests that the inclusion of goat manure helped to mitigate these adverse effects. The combination of goat and poultry manure appeared to balance the physical and thermal properties of the planting medium, allowing plants to grow optimally under all treatment conditions. This finding aligns with the report of Sinaga, Dahang, and Tarigan (2021), who noted that the fibrous texture of goat manure contributes to improved soil aeration and serves as a stabilizing agent for both moisture and temperature in the growing substrate.

Planting media ratio of 3:2:1 (K2), consisting of 3 kg soil, 2 kg goat manure, and 1 kg poultry manure, produced the highest average plant height. This combination appears to be optimal because the relatively smaller proportion of poultry manure prevented excessive heat generation in the growing medium while still supplying sufficient amounts of essential nutrients, particularly nitrogen (N) and phosphorus (P), required for vegetative growth. Poultry manure contains nitrogen in readily decomposable forms that are quickly available to plants, along with phosphorus that promotes root development and leaf expansion (Wulandari, Guritno, & Aini, 2014).

Adequate nitrogen and phosphorus availability also contribute to increased leaf number and size, as well as enhanced chlorophyll content, all of which are critical for improving photosynthetic efficiency. In this context, photosynthesis acts as the central physiological process driving biomass accumulation, influencing stem elongation, leaf production, and the formation of branches and new shoots. Therefore, a balanced planting medium that harmonizes nutrient composition and physical properties serves as a key determinant of successful cucumber (*Cucumis sativus* L.) growth and overall plant vigor.

The number of leaves is an important vegetative growth parameter, as it directly influences the plant's photosynthetic capacity and overall vigor. Leaf development reflects the plant's ability to absorb and utilize nutrients effectively, especially nitrogen and phosphorus. Observations of the average number of leaves are presented in Table 3.

Table 3. Average Number of Leaves of Cucumber Under Different Planting Media Compositions

Treatment	Average Number of Leaves		
	7 DAS	14 DAS	21 DAS
K1	3.75	7.25	16.50b
K2	3.75	7.75	20.00bc
K3	3.50	7.75	18.50bc
K4	3.75	8.00	16.75b
K5	4.00	7.50	16.75b
K6	4.00	6.50	12.25a
K7	4.00	7.50	21.50c
LSD 5%	ns	ns	4.17

Note: Means followed by the same letter within a column are not significantly different according to 5% LSD test.
Source: Primary Data Analysis (2025)

Based on the results of the analysis of variance (ANOVA) at 21 days after sowing (DAS), the composition of the planting medium had a significant effect on the number of cucumber (Cucumis sativus L.) leaves, as presented in Table 3. This difference indicates that the composition of organic materials within the growing medium began to exert a measurable influence on vegetative growth at this stage. In contrast, no significant differences were observed among treatments during the early growth period (7–14 DAS). This is likely because, during the initial growth phase, nutrients from organic materials such as manure had not yet undergone complete decomposition and therefore were not fully available in forms readily absorbed by plants (Wijaksono, Subiantoro, & Utoyo, 2016).

Generally, organic matter requires time to undergo mineralization, a process in which complex organic compounds are converted into simpler, plant-available nutrients such as nitrogen and other macronutrients. As a result, the impact of organic fertilizer composition on vegetative parameters such as leaf number tends to become evident only after sufficient mineralization has occurred, typically around 21 DAS.

When observed from the perspective of leaf number, cucumber growth is highly dependent on the availability of nitrogen (N). Nitrogen is an essential macronutrient that plays a fundamental role in the formation of vegetative tissues, particularly leaves. Poultry manure is known to contain a higher nitrogen content compared to goat manure, thereby contributing more effectively to stimulating leaf formation and overall vegetative growth (Dinas Pangan, Pertanian dan Perikanan Kota Yogyakarta, 2018). Consequently, treatments without poultry manure—such as K6 (a composition of 3 kg soil : 3 kg goat manure: 0 kg poultry manure)—resulted in a significantly lower number of leaves compared to treatments containing poultry manure. This finding reinforces the crucial role of nitrogen in supporting the vegetative growth phase of

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cucumber plants, particularly in promoting leaf development and photosynthetic capacity.

Branch formation also holds vegetative vigor and overall plant productivity, as it contributes to the potential number of flowering sites and subsequently fruit yield. The effect of planting media composition on the average number of branches of cucumber (Cucumis sativus L.) was observed at 14 and 21 days after sowing (DAS). The results are presented in Table 4.

Table 4. Cucumber's Average Number of Branches as Affected by Planting Media Composition

Treatment	Average Number of Branches	
	14 DAS	21 DAS
K1	7.25	16.50b
K2	7.75	20.00bc
K3	7.75	18.50bc
K4	8.00	16.75b
K5	7.50	16.75b
K6	6.50	12.25a
K7	7.50	21.50c
LSD 5%	ns	4.17

Note: Means followed by the same letter within a column are not significantly different according to 5% LSD test.
Source: Primary Data Analysis (2025)

Based on the data in Table 4, the composition of the planting medium significantly affected branch formation at both 14 and 21 DAS. Treatments K1 (2:2:2), K2 (3:2:1), K5 (1:2:3), and K7 (3:0:3) consistently produced more branches compared to K3 (3:1:2), K4 (1:3:2), and particularly K6 (3:3:0), which resulted in the lowest branch number. The superior performance of media containing poultry manure may be attributed to its relatively fast decomposition rate, allowing quicker nutrient mineralization, particularly nitrogen and phosphorus, which are essential for vegetative growth and branching (Sari et al., 2020).

At 21 DAS, this trend became more pronounced, suggesting that the availability of readily decomposed organic nutrients continued to influence plant vigor. The low branching in treatment K6, which lacked poultry manure, indicates a nutrient limitation (particularly nitrogen deficiency) during the critical stage of vegetative expansion. This result aligns with the general understanding that nitrogen stimulates cell division and elongation in shoot meristems, thereby promoting the initiation of lateral branches. Conversely, the combination of goat and poultry manure helped maintain optimal nutrient balance and improved soil structure, facilitating better root development and nutrient uptake, ultimately supporting more vigorous branching.

Harvesting of cucumber plants (*Cucumis sativus* L.) began at 34 days after sowing (DAS), marked by the disappearance of fine hairs on the fruit surface as an indicator of maturity. All harvested fruits were measured for length to obtain primary data for evaluating the effect of planting media composition on yield components. Fruit length serves as a key parameter reflecting the success of vegetative-to-reproductive transition and the adequacy of nutrient supply during fruit development. The results are presented in Table 5.

Table 5. Average Fruit Length of Cucumber as Affected by Planting Media Composition

Treatment	Average Fruit Length (cm)				
	34 DAS	37 DAS	40 DAS	43 DAS	46 DAS
K1	10.75	20.75b	29.25	19.00b	4.75
K2	21.25	21.50b	24.25	19.50b	4.88
K3	15.25	21.00b	14.50	9/25a	2.31
K4	20.75	21.50b	24.00	24.75b	6.19
K5	14.75	20.25b	17.50	9.00a	2.25
K6	4.50	5.00a	8.50	4.25a	1.06
K7	20.75	21.00b	27.50	15.00ab	3.75
LSD 5%	ns	5.74	ns	12.67	ns

Note: Means followed by the same letter within a column are not significantly different according to 5% LSD test.
Source: Primary Data Analysis (2025)

At 37 DAS, the effect of planting media composition on fruit length was statistically significant. Treatments containing poultry manure, such as K1 (2:2:2), K2 (3:2:1), K4 (1:3:2), K5 (1:2:3), and K7 (3:0:3), produce longer fruits compared to K6 (3:3:0), which lacked poultry manure. In cucumber plants (Cucumis sativus L.), fruit elongation occurs rapidly during the enlargement phase, which typically spans from approximately 34 to 43 days after sowing (DAS). Beyond this period, growth slows down or ceases as the fruit enters the physiological maturation phase (>43 DAS). Once the fruit reaches its maximum length, further growth shifts toward tissue filling, rind thickening, and seed maturation. Consequently, a slight decrease in measured fruit length may occur due to natural shrinkage during the ripening process (Anugrah et al., 2020).

This finding suggests that the nutrient composition derived from poultry manure plays a vital role during the early stages of fruit elongation. Poultry manure contains readily available nitrogen and phosphorus that support rapid cell division and fruit expansion (Wulandari, Guritno, & Aini, 2014). These elements play vital roles in fruit formation, particularly during the enlargement and elongation phases that intensify once the plant enters the generative stage (Rahul, 2020). Potassium, in particular, is essential for osmotic regulation and cell expansion, directly contributing to increased fruit length. These findings suggest that a balanced combination of goat

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and poultry manure in the planting medium is crucial for optimizing fruit quality, especially in terms of size. However, this effect became more apparent after 37 days after sowing (DAS), as the early fruit development phase (around 34 DAS) represents a physiological transition from flowering to young fruit formation, during which the influence of treatments on fruit elongation is not yet fully expressed.

Table 6. Average Cucumber's Diameter as Affected by Planting Media Composition

Treatment	Average Fruit Diameter (mm)				
	34 DAS	37 DAS	40 DAS	43 DAS	46 DAS
K1	24.37	41.98b	70.35	46.43	47.25
K2	42.40	48.60b	59.70	46.25	34.95
K3	33.58	48.23b	34.35	23.35	28.43
K4	50.38	46.20b	58.33	56.93	35.25
K5	38.00	48.30b	45.90	22.45	33.60
K6	12.18	10.60a	22.50	20.90	25.20
K7	47.43	49.93b	74.95	25.05	46.35
LSD 5%	ns	12.15	ns	ns	ns

Note: Means followed by the same letter within a column are not significantly different according to 5% LSD test.
Source: Primary Data Analysis (2025)

Observations from the first harvest, conducted AT 37 days after sowing (DAS), revealed that the composition of the planting medium had a significant effect on the fruit diameter of cucumber (Table 6). Treatments containing a combination of goat manure and poultry manure such as K1, K2, and K7 tended to produce fruits with larger diameters compared to treatments that did not include poultry manure. This indicates that the balanced nutrient supply from both manure types supports more optimal fruit expansion during the early stages of fruit development.

At 37 DAS, the treatment containing both goat and poultry manure (K1, K2, and K7) produced significantly larger fruit diameters compared to treatments without poultry manure, particularly K6 (3:3:0). This indicates that nutrient balance between organic sources plays an essential role in fruit thickening during the early stages of development. Poultry manure provides a readily available source of nitrogen and phosphorus that promotes rapid cell division and fruit tissue expansion, while goat manure improves soil structure and enhances moisture retention creating favorable conditions for uniform fruit growth.

One of the factors contributing to the smaller fruit diameter observed in treatment K6 (3 kg soil : 3 kg goat manure : 0 kg chicken manure) was the limited availability of nitrogen (N) in the growing medium. Nitrogen is an essential macronutrient that plays a crucial role in the formation of vegetative tissues, protein synthesis, and chlorophyll production, all of which indirectly influence photosynthetic activity and fruit enlargement (Nurhayati et al., 2015). Insufficient nitrogen supply can inhibit plant growth and reduce the accumulation of photosynthates necessary for cell expansion and fruit development.

Moreover, the addition of organic materials through manure application aims to provide a gradual nutrient supply throughout both vegetative and generative growth stages. The combination of chicken and goat manure offers complementary benefits: chicken manure supplies readily available nutrients, particularly nitrogen and phosphorus, while goat manure improves soil structure and releases nutrients more slowly over time. Therefore, a balanced mixture of these two organic fertilizers creates a more stable and productive growing medium, thereby supporting optimal fruit enlargement during the early harvesting phase.

Table 7. Average Fruit Number as Affected by Planting Media Composition

Treatment	Number of Fruits
K1	4.75bc
K2	4.75bc
K3	3.75b
K4	5.25c
K5	4.25bc
K6	2.00a
K7	4.25bc
LSD 5%	1.04

Note: Means followed by the same letter within a column are not significantly different according to 5% LSD test.
Source: Primary Data Analysis (2025)

Based on the average number of cucumber fruits across five harvests (Table 7), the composition of the planting medium had a significant effect on the number of fruits per plant. The Least Significant Difference (LSD) test at the 5% significance level indicated a critical value of 1.04, meaning that any difference in mean values between treatments equal to or greater than 1.04 can be considered statistically significant.

Treatment K4 (1 kg soil : 3 kg goat manure : 2 kg chicken manure) produced the highest fruit number, averaging 5.25 fruits per plant, and was significantly different from treatment K6, which yielded the lowest fruit number of only 2.00 fruits per plant. The superior performance of K4 is likely attributed to the dominant proportion of goat manure in the planting medium, which is known for its fibrous organic structure that enhances soil water retention and supports gradual nutrient release. Meanwhile, treatments K1, K2, K5, and K7 produced between 4.25 and 4.75 fruits per plant, showing no significant differences among them according to the LSD test. This finding indicates that a balanced combination of soil, goat manure, and chicken manure tends to promote better fruit productivity compared to disproportionate media compositions.

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Treatment K6 (without chicken manure) produced the lowest number of fruits per plant, with a statistically significant difference compared to other treatments. This outcome is likely due to insufficient nitrogen availability, an essential macronutrient responsible for stimulating flower initiation and fruit formation. Chicken manure contains higher concentrations of nitrogen and phosphorus than goat manure, both of which are crucial during the generative phase of cucumber growth (Sari et al., 2020; Nurhayati et al., 2015). Therefore, these findings suggest that a balanced composition of chicken and goat manure in the planting medium is more effective in enhancing fruit production. Conversely, nutrient imbalance—particularly nitrogen and phosphorus deficiency—negatively affects the plant's reproductive development and overall productivity.

The appropriate composition of the planting medium plays a vital role in supporting cucumber fruit production that meets market quality standards, particularly in terms of harvestable fruit weight. As shown in Table 8, treatments K1 (2:2:2), K3 (3:1:2), and K7 (3:0:3) produced fruit weights that were not significantly different, despite not containing goat manure in full proportion. This suggests that the absence of goat manure did not significantly affect the final fruit weight, provided that essential nutrients were adequately supplied through chicken manure and soil. In contrast, treatment K6 (3:3:0), which excluded chicken manure, showed a reduction in fruit weight of up to 80% compared with other treatments. This result indicates that the presence of chicken manure is crucial for cucumber fruit formation and filling, primarily because it serves as a major source of phosphorus (P) and potassium (K) key nutrients that play critical roles during the generative growth phase, particularly in fruit enlargement and ripening.

Phosphorus plays a vital role in energy translocation and the development of reproductive organs, while potassium contributes to osmotic regulation and fruit cell expansion. Together, these nutrients support the formation of large, heavy fruits with higher market value. Chicken manure is also characterized as a slow-release fertilizer, allowing its nutrients to become gradually available and optimally absorbed during the generative phase (Dewi, 2018). Therefore, the absence of chicken manure in the planting medium results in inadequate phosphorus and potassium supply during the critical stage of fruit development, ultimately leading to a significant reduction in cucumber fruit weight.

CONCLUSION

Based on observations and data analysis, it can be concluded that the composition of the planting medium had a significant effect on both vegetative growth parameters and yield components of cucumber (*Cucumis sativus* L.). The treatment consisting of a proportional combination of soil, goat manure, and chicken manure effectively supported optimal plant growth, as reflected in higher plant height, leaf number, and branch number compared to other treatments. The composition of the planting medium also significantly influenced yield parameters, including fruit length, fruit diameter, number of fruits per plant, and fruit weight. Among the treatments, K4 (1 kg soil : 3 kg goat manure : 2 kg chicken manure) was identified as the most effective composition, producing the highest number of fruits over five consecutive harvests. In contrast, the treatment without chicken manure (K6) resulted in the lowest values across both growth and yield parameters. This finding highlights the crucial role of chicken manure, rich in nitrogen and phosphorus as supporting key physiological processes during the generative phase. Overall, cucumber growth and productivity are strongly influenced by the nutrient composition of the planting medium, and a balanced combination of goat and chicken manure serves as a critical determinant for enhancing both vegetative vigor and generative performance.

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