



Effects of Growing Media on Growth and Yield of Potato (*Solanum tuberosum* L.) under a Hydroponic Drip System

Muhammad Ansori

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Abstract: The limited efficiency of conventional seed potato production systems highlights the need for alternative cultivation strategies to improve productivity and planting material quality. Hydroponic systems offer a promising solution; however, comparative evidence regarding suitable growing media for potato production under tropical highland greenhouse conditions remains limited. This study aimed to evaluate the effects of potato variety and growing medium on plant growth and tuber yield under a hydroponic drip irrigation system. A factorial experiment was conducted using two potato varieties (Granola L and Tedjo MZ) and two growing media (rice husk charcoal and cocopeat), arranged in a completely randomized design with ten replicates. Plants were cultivated under greenhouse conditions and supplied with a commercial AB-mix nutrient solution. Data were analyzed using analysis of variance followed by the least significant difference test at the 1% significance level. The results showed that growing medium significantly affected all measured growth and yield parameters, whereas potato variety and the interaction between factors had no significant effects. Cocopeat produced greater plant height (50.70 cm), number of leaves (61.65 plant⁻¹), tuber number (19.35 tubers plant⁻¹), tuber fresh weight (466.87 g plant⁻¹), and tuber volume (404.28 cm³ plant⁻¹) than rice husk charcoal. In conclusion, substrate selection was the key factor influencing hydroponic potato performance under the tested conditions, and cocopeat was the more suitable medium for improving seed potato production efficiency in tropical highland regions and similar environments worldwide sustainably.

Introduction

Potato (*Solanum tuberosum* L.) is one of the most important food crops worldwide, serving as a major source of carbohydrates, proteins, vitamins, and minerals (1). In Indonesia, potato ranks among the leading horticultural commodities after rice and maize, with increasing demand driven by population growth, urbanization, and the expansion of food processing industries (2, 3). However, national potato production has shown limited progress and remains unstable, with annual outputs fluctuating rather than exhibiting sustained growth (4). Recent production statistics indicate that Indonesian potato yields stagnated at approximately 1.28-1.31 million tons between 2018 and 2020, highlighting a persistent gap between demand and supply (5). This stagnation is exacerbated by climate variability, declining soil fertility, pest and disease pressure, and limited availability of high-quality seed tubers, collectively threatening production sustainability and food security (6).

One of the most critical constraints in potato cultivation is the low availability of certified, high-quality planting material. Many farmers rely on recycled seed tubers from previous harvests, leading to genetic degeneration, yield reduction, and increased vulnerability to diseases (7). Although improved varieties such as Granola L and Tedjo MZ have been released with favorable agronomic traits, including disease tolerance and high yield potential, their performance is strongly influenced by cultivation systems and growing media (8). Conventional soil-based cultivation further faces challenges related to land degradation, nutrient imbalance, and inefficient water use (9). In response, hydroponic cultivation systems, particularly drip irrigation, have emerged as promising alternatives due to their precise control over water and nutrient supply, reduced disease incidence, and suitability for seed tuber production (10). Nevertheless, the success of hydroponic potato cultivation largely depends on the selection of appropriate growing media that can provide optimal aeration, water retention, and nutrient availability (

11). Commonly used substrates such as rice husk charcoal and cocopeat differ substantially in their physical and chemical properties, which may critically affect plant growth and tuber development (12).

Despite increasing interest in hydroponic potato production, comparative studies integrating varietal performance and growing media under drip irrigation systems remain limited, particularly under tropical highland conditions (13). Recent evidence indicates that soilless cultivation performance is strongly influenced by substrate characteristics, as porous media regulate water retention, aeration, and nutrient dynamics, ultimately affecting plant physiological processes and yield formation. Previous studies also emphasize that substrate physical characteristics, especially water-holding capacity and porosity, play a critical role in determining crop performance in soilless systems (14). This research addresses this gap by evaluating the growth and yield responses of two potato varieties, Granola L and Tedjo MZ, cultivated hydroponically using different planting media (15). The novelty of this study lies in its integrated assessment of varietal adaptability and substrate performance within a controlled drip irrigation system, offering insights into optimized strategies for sustainable potato production. This study aimed to determine the effects of potato variety and growing media on plant growth and tuber yield under hydroponic drip irrigation. A factorial experiment arranged in a completely randomized design was conducted in a greenhouse, with growth and yield parameters systematically measured to elucidate treatment effects. The findings are expected to contribute to the development of efficient, resource-saving potato production systems and support the advancement of high-quality seed tuber production in Indonesia and similar agroecological regions.

Methodology

Study Design and Experimental Rationale

The study was conducted to evaluate the individual and interactive effects of potato variety and growing medium on plant growth and tuber yield under a controlled hydroponic drip irrigation system. The experiment was conducted from March to June 2022. A factorial experimental design was employed to enable simultaneous assessment of varietal response and substrate performance, which is critical for optimizing hydroponic potato production systems. The experiment was arranged using a completely randomized design (CRD) to minimize environmental bias within the greenhouse and to ensure statistical robustness. All treatments were randomly assigned to experimental units to minimize positional effects within the greenhouse. Each replicate consisted of a single plant grown in an individual polybag, resulting in a total of 40 experimental units.

Experimental Site and Growth Conditions

The experiment was carried out in a controlled greenhouse facility at the Kledung Research Park, Faculty of Agriculture, Tidar University, Temanggung Regency, Indonesia (1,106 m above sea level). The site represents a tropical highland agroecological zone suitable for potato cultivation. The greenhouse was constructed with a steel frame, covered with UV-resistant plastic roofing, and

enclosed with insect-proof netting to reduce pest intrusion and microclimatic variability. Environmental parameters were monitored daily, with average temperatures ranging from 15–22 °C and relative humidity maintained between 70–85%. Light intensity inside the greenhouse was maintained under natural conditions and monitored periodically, while ventilation openings were used to ensure adequate air circulation and stabilize internal microclimatic conditions.

Plant Material and Treatments

Two potato (*Solanum tuberosum* L.) varieties, Granola L and Tedjo MZ, were used as plant material. Granola L is a commonly cultivated variety, while Tedjo MZ is a derivative developed from Granola. Uniform, visually healthy plantlets aged 14 d, propagated from vegetative cuttings, were obtained from the Kledung Seed Center and used to minimize variability in plant age and size at transplanting.

The growing media evaluated in this study were rice husk charcoal and cocopeat. Rice husk charcoal was selected as a porous substrate with low water-holding capacity, whereas cocopeat was used as a substrate with relatively higher water retention and moderate nutrient content. Cocopeat is characterized by high water-holding capacity (up to approximately 70%) and good nutrient retention, whereas rice husk charcoal has higher porosity and aeration but lower water retention, which may influence root-zone moisture dynamics and nutrient availability.

Hydroponic System and Nutrient Management

Plants were cultivated using a hydroponic drip irrigation system equipped with an automated timer. The nutrient solution was supplied through pressure-compensated drippers connected to polyethylene lateral lines, with a commercial AB-mix formulation used as the sole source of mineral nutrients. The AB-mix consisted of two stock solutions containing essential macroelements (N, P, K, Ca, Mg, and S) and microelements (Fe, Mn, Zn, Cu, and B), which were supplied in balanced proportions to support plant growth. Nutrient concentration was adjusted according to plant developmental stage, with electrical conductivity maintained at approximately 1.0 mS cm⁻¹ during 0–30 d after transplanting, 1.5 mS cm⁻¹ during 30–50 d after transplanting, and 2.0 mS cm⁻¹ thereafter until harvest.

The pH of the nutrient solution was maintained within a range of 6.0–6.5 through the addition of potassium hydroxide or phosphoric acid as required. Electrical conductivity and pH were measured twice daily using calibrated digital meters. Irrigation frequency and duration were adjusted according to plant age, with nutrient solution applied two to four times per day, and each irrigation event lasting approximately one minute.

Crop Management

Plants were maintained under uniform management practices throughout the experiment. Pest control was conducted using integrated approaches, including mechanical trapping and targeted insecticide application against *Bemisia tabaci* when necessary. Diseased plants were immediately removed to prevent pathogen spread. No growth regulators were applied during the study. All plants were maintained under uniform agronomic

Table 1. Summary of analysis of variance (F-values) for growth and yield parameters.

Parameter	Variety	Growing medium (M)	V×M
Plant height	ns	**	ns
Leaf number	ns	**	ns
Tuber number	ns	**	ns
Tuber weight	ns	**	ns
Tuber volume	ns	**	ns
Shoot fresh weight	ns	**	ns
Root fresh weight	ns	**	ns
Shoot dry weight	ns	**	ns
Root dry weight	ns	**	ns

Notes: ** significant at $p < 0.01$; ns = not significant.

practices to minimize variability unrelated to treatment effects.

Data Collection

Growth and yield parameters were measured to evaluate vegetative development, biomass accumulation, and tuber production under different experimental treatment conditions. Measurements were conducted on all experimental units, with one plant per replicate used as the sampling unit throughout the observation period. Observations included plant height, number of leaves per plant, number of tubers per plant, tuber fresh weight per plant, tuber volume per plant, and fresh and dry biomass of shoots and roots. Vegetative parameters were recorded at 49 d after transplanting, while yield-related measurements were conducted at harvest at 90 d after transplanting under controlled experimental conditions. Dry biomass was determined by oven-drying plant

samples at 105 °C for 48 h until a constant weight was achieved before final biomass calculation.

Statistical Analysis

All data were subjected to analysis of variance (ANOVA) appropriate for a two-factor factorial CRD. The effects of variety, growing medium, and their interaction were tested at the 5% and 1% significance levels. When significant differences were detected, treatment means were compared using the least significant difference (LSD) test at the 1% probability level. Statistical analyses were performed using SPSS software (version 25). Prior to analysis, data were tested for normality and homogeneity of variance to ensure that ANOVA assumptions were satisfied.

Results

Effects of Variety, Growing Medium, and Their Interaction

Analysis of variance indicated that potato variety had no significant effect on any of the observed growth and yield parameters (**Table 1**). Likewise, the interaction between variety and growing medium was not significant across all variables, indicating that both varieties responded similarly to the growing media under the experimental conditions.

In contrast, the growing medium significantly affected all measured vegetative growth, biomass accumulation, and tuber yield parameters at the 1% significance level. These results demonstrate that plant performance was primarily determined by substrate type rather than varietal differences in this hydroponic system.

Effects of Growing Medium on Vegetative Growth

The growing medium markedly influenced the vegetative growth of potato plants (**Table 2**). Plants cultivated in cocopeat exhibited greater plant height and higher leaf number than those grown in rice husk charcoal. These

Table 2. Effects of growing medium on vegetative growth and biomass of potato plants.

Parameter	Rice husk charcoal	Cocopeat
Plant height (cm)	24.93 b	50.70 a
Leaf number (leaves plant ⁻¹)	24.80 b	61.65 a
Shoot fresh weight (g plant ⁻¹)	40.65 b	337.23 a
Root fresh weight (g plant ⁻¹)	5.03 b	26.71 a
Shoot dry weight (g plant ⁻¹)	5.09 b	32.30 a
Root dry weight (g plant ⁻¹)	0.46 b	1.94 a

Note: Values followed by different letters differ significantly at $p < 0.01$

Table 3. Effects of growing medium on tuber yield of potato plants.

Parameter	Rice husk charcoal	Cocopeat
Tuber number (tubers plant ⁻¹)	6.05 b	19.35 a
Tuber weight (g plant ⁻¹)	90.91 b	466.87 a
Tuber volume (cm ³ plant ⁻¹)	76.98 b	404.28 a

Note: Values followed by different letters differ significantly at $p < 0.01$.

differences were consistent across all replications and statistically significant at the 1% level.

In addition to shoot growth, biomass accumulation was also higher in cocopeat-grown plants. Shoot and root fresh weights, as well as shoot and root dry weights, were substantially greater in cocopeat than in rice husk charcoal, indicating enhanced vegetative development under this medium.

Effects of Growing Medium on Tuber Yield

Growing medium significantly affected all tuber yield components (**Table 3**). Cocopeat resulted in a higher number of tubers per plant compared with rice husk charcoal, indicating a more favorable yield response under this medium.

Similarly, tuber weight and tuber volume per plant were significantly greater in cocopeat than in rice husk charcoal. The consistency of responses across all yield-related parameters indicates that the effect of growing medium on tuber production was uniform and pronounced under the conditions of this study.

Discussion

The results indicate that the growing medium was the primary factor influencing potato growth and yield under the hydroponic system, whereas cultivar and its interaction with the growing medium did not show significant effects (16). The absence of varietal differences is likely attributable to the close genetic relationship between Granola L and Tedjo MZ, as the latter was developed through selection from Granola-derived material (17). Such genetic similarity may result in comparable physiological responses, particularly in terms of water use efficiency, nutrient uptake, and assimilate partitioning, when both cultivars are cultivated under identical environmental and hydroponic conditions (18). This suggests that under controlled environments, genetic variability may be less expressed compared to open-field conditions, where environmental stressors often amplify genotypic differences.

The superior performance of cocopeat in supporting vegetative growth and biomass accumulation can be explained by its favorable physical properties, especially its higher water-holding capacity and ability to maintain a more stable root-zone environment compared with rice husk charcoal (19, 20). A stable root-zone moisture condition is essential for maintaining continuous nutrient availability and preventing transient water stress, which directly affects cell expansion, leaf area development, and overall plant vigor. In contrast, the higher porosity and lower water retention of rice husk charcoal may lead to rapid drainage and reduced moisture availability between irrigation intervals (21), thereby limiting water and nutrient uptake efficiency under the hydroponic conditions applied in this study.

The higher tuber yield observed in plants grown in cocopeat further indicates that improved vegetative growth contributes to enhanced photosynthate production and allocation to storage organs. Increased leaf area likely improves light interception and photosynthetic capacity, thereby increasing carbohydrate supply for tuber initiation and bulking. In addition, a more favorable root environment ensures a continuous supply of water and nutrients during critical growth stages, which

is essential for tuber development. These results are consistent with the concept that both source strength (photosynthesis) and sink capacity (tuber formation) must be optimized to achieve higher yield in potato production systems.

Overall, the findings emphasize that the selection of an appropriate growing medium is a critical determinant of hydroponic potato production efficiency. Under the conditions of this study, cocopeat provided a more favorable balance of water retention and aeration than rice husk charcoal, resulting in improved vegetative growth and tuber yield. However, these findings should be interpreted within the experimental scope, including the specific cultivars, hydroponic system configuration, and environmental conditions used, and may require further validation under different agroecological settings.

Conclusion

The present study demonstrated that growing medium was the main factor affecting the growth and yield performance of hydroponically cultivated potato, whereas potato variety and its interaction with growing medium had no significant effects under the tested conditions. Cocopeat provided a more favorable root-zone environment than rice husk charcoal, resulting in improved vegetative growth, biomass accumulation, and tuber yield. These findings highlight the importance of appropriate substrate selection for enhancing the efficiency and productivity of hydroponic potato cultivation, particularly for seed tuber production in tropical highland environments. However, the results were obtained using only two closely related cultivars under a single greenhouse system; therefore, further studies involving broader genotypes, alternative substrates, and different environmental conditions are recommended to validate and expand these findings.

Declaration

Author Information

Muhammad Ansori

*Corresponding author

Department of Agrotechnology, Faculty of Agriculture, Tidar University, Magelang - 56116, Indonesia.

Contribution: Data Curation, Formal analysis, Visualization, Writing - Original Draft, Writing - Review & Editing, Writing – Original Draft.

Conflict of Interest

The author declares no conflicting interest.

Data Availability

All data generated or analyzed during this study are included in this published article.

Ethics Statement

Ethical approval was not required for this study.

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References

- World Food and Agriculture – Statistical Yearbook 2024. *Fao*; 2024. doi: <https://doi.org/10.4060/cd2971en>
- Jannah HFK, Karyanto A, Agustiansyah A. Pengaruh Ukuran Umbi Bibit dan Paclobutrazol Pada Pertumbuhan dan Hasil Umbi Tanaman Kentang (*Solanum tuberosum* L.). *Jat.* 2024;12(4):984. doi: <https://doi.org/10.23960/jat.v12i4.7616>
- Indonesia's Potato Market Report 2026 - Prices, Size, Forecast, and Companies [Internet]. Available from: <https://www.indexbox.io/store/indonesia-potato-market-report-analysis-and-forecast-to-2020/>
- Potato Production and Consumption [Internet]. Available from: <https://www.potatopro.com/potato-markets/indonesia>
- Produksi Tanaman Sayuran - Tabel Statistik - Badan Pusat Statistik Indonesia [Internet]. Available from: <https://www.bps.go.id/id/statistics-table/2/NjEjMg==/produksi-tanaman-sayuran.html>
- Suhandi RAP, Kusumo RAB, Hapsari H, Heryanto MA. Analisis Risiko Produksi Kentang di Desa Sarimukti Kecamatan Pasirwangi Kabupaten Garut. *ma. mimb. agribisnis. jurnal. pemikir. masy. ilm. berwawasan. agribisnis.* 2025;11(1):255. doi: <https://doi.org/10.25157/ma.v11i1.15364>
- Muthoni J, Shimelis H, Melis R. Alleviating potato seed tuber shortage in developing countries: Potential of true potato seeds. *AJCS.* 2013.
- Teftae OY, Noywuli N, Noa M, Simo D. Pengaruh Pemberian Pupuk Kotoran Sapi Terhadap Pertumbuhan dan Hasil Tanaman Kentang (*Solanum Tuberosum* L.) Varietas Granola. *agtumb.* 2025;20(1):1-18. doi: <https://doi.org/10.36085/agrotek.v20i1.8285>
- Karanja AM, Shisanya C, Makokha G. Analysis of the Key Challenges Facing Potato Farmers in Oljoro-Orok Division, Kenya. *As.* 2014;05(10):834-838. doi: <https://doi.org/10.4236/as.2014.510088>
- Suharto YB. Rancang Bangun Sistem Hidroponik Kombinasi Irigasi Tetes, Sumbu, Dan Nutrient Film Technique Untuk Budidaya Tanaman Kentang. [Internet]. 2016. Available from: <http://repository.ipb.ac.id/handle/123456789/81506>
- Suharto Y, Suhardiyanto H, Susila A. Pengembangan Sistem Hidroponik untuk Budidaya Tanaman Kentang (*Solanum tuberosum* L.). *Jtep.* 2016;04(2):1-8. doi: <https://doi.org/10.19028/jtep.04.2.211-218>
- Sitepu HP, Pandia W, Tarigan S. Comparison of Planting Media Types on Vegetative Growth of Mini Potato Cuttings (*Solanum Tuberosum* L.) Granola L Variety. *Journal Of Berastagi Agriculture (JOBA)* [Internet]. 2025;4(1):1-9. Available from: <http://portaluqb.ac.id:7576/ojs/index.php/jurnalmaksibisnis/article/view/731>
- Woznicki T, Møllerhagen PJ, Heltoft P, Kusnierek K. Growing Potatoes (*Solanum tuberosum* L.) Hydroponically in Wood Fiber—A Preliminary Case-Study Report. *Agronomy.* 2021;11(7):1369. doi: <https://doi.org/10.3390/agronomy11071369>
- Sharma A, Manpoong C, Devadas VS, Kartha BD, Pandey H, Wangsu M. Crop Hydroponics, Phytohydroponics, Crop Production, and Factors Affecting Soilless Culture. *ACS Agric. Sci. Technol.* 2022;2(6):1134-1150. doi: <https://doi.org/10.1021/acscagcitech.2c00243>
- Aulia N. Perbedaan Pertumbuhan dan Hasil Dua Varietas Kentang yang Ditanam Secara Aeroponik. 2022.
- Kusnierek K, Heltoft P, Møllerhagen PJ, Woznicki T. Hydroponic potato production in wood fiber for food security. *npj Sci Food.* 2023;7(1). doi: <https://doi.org/10.1038/s41538-023-00200-7>
- Hadi SN, Nurchasanah S. Genetic Diversity of Potato Based on Random Amplified Polymorphic DNA and Simple Sequence Repeat Marker. *pt.* 2020;8(1). doi: <https://doi.org/10.18196/pt.2020.114.54-62>
- Terryana RT, Prihaningsih A, Nugroho K, Kusmana, Lestari P, Wardhana INA, et al. Diversity of 33 Genotypes of Potato Revealed by Simple Sequence Repeats Markers. *Joaat.* 2022. doi: <https://doi.org/10.18178/joaat.9.2.40-45>
- Awang. Chemical and Physical Characteristics of Cocopeat-Based Media Mixtures and Their Effects on the Growth and Development of *Celosia cristata*. *American Journal of Agricultural and Biological Sciences.* 2009;4(1):63-71. doi: <https://doi.org/10.3844/ajabssp.2009.63.71>
- Djaingsastro AJ, Sinaga H, Sitorus RM. The effect of cocopeat and rice husk planting media hydroponically on the growth of palm oil in pre nursery. *Biolink.* 2021;7(2):195-203. doi: <https://doi.org/10.31289/biolink.v7i2.4115>
- Zainal Alam MNH, Ali Othman NSI, Samsudin SA, Johari A, Hassim MH, Kamaruddin MJ. Carbonized Rice Husk and Cocopeat as Alternative Media Bed for Aquaponic System. *Jsm.* 2020;49(3):483-492. doi: <https://doi.org/10.17576/jsm-2020-4903-03>

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