

Differences in Growth and Yield Responses of Several Cayenne Pepper (*Capsicum frutescens* L.) Varieties in Cocoa (*Theobroma cacao* L.) Interrows

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Abstract

*This study aimed to analyze the response of several cayenne pepper varieties (*Capsicum frutescens* L.) on the growth and yield of cayenne pepper cultivated in the cocoa (*Theobroma cacao* L.) alley cropping system. The research was conducted from April to July 2025 at Mon Jambe Village, Jeumpa District, and the Kopbun Suka Tani Sejahtera Business Research Center, Kota Juang District, Bireuen Regency. The experiment employed a Randomized Block Design (RBD) with four varieties as treatments and three replications, resulting in 12 experimental units. The tested varieties were Rajo, Genie, Bara, and Tetra Hijau. Data were collected through observations of plant height, number of leaves, number of fruits, fruit weight, and fresh biomass weight, and were analyzed using analysis of variance (ANOVA) to determine differences among treatments. The results showed that the varietal factor had a highly significant effect on leaf number and a significant effect on fruit number and fruit weight. The Bara variety exhibited the most adaptive and productive performance under the cocoa alley cropping system, as indicated by superior vegetative growth and yield compared to other varieties. The novelty of this study lies in emphasizing that varietal selection is a key factor in optimizing the utilization of cocoa alley spaces for cayenne pepper cultivation. These findings are expected to provide a scientific basis for developing cayenne pepper cultivation technologies in cocoa alley systems and to serve as a reference for further research on adaptive variety development under such environmental conditions.*

Keywords:

Variety
Cayenne pepper
Cocoa interrows

Abstrak

Penelitian ini bertujuan untuk menganalisis respons beberapa varietas cabai rawit (*Capsicum frutescens* L.) terhadap pertumbuhan dan hasil panen cabai rawit yang ditanam dalam sistem tumpang sari kakao (*Theobroma cacao* L.). Penelitian ini dilakukan dari April hingga Juli 2025 di Desa Mon Jambe, Kecamatan Jeumpa, dan Pusat Penelitian Bisnis Kopbun Suka Tani Sejahtera, Kecamatan Kota Juang, Kabupaten Bireuen. Eksperimen menggunakan Rancangan Blok Acak (RBD) dengan empat varietas sebagai perlakuan dan tiga ulangan, menghasilkan 12 unit eksperimen. Varietas yang diuji adalah Rajo, Genie, Bara, dan Tetra Hijau. Data dikumpulkan melalui pengamatan tinggi tanaman, jumlah daun, jumlah buah, berat buah, dan berat biomassa segar, dan dianalisis menggunakan analisis variansi (ANOVA) untuk menentukan perbedaan antar perlakuan. Hasil penelitian menunjukkan bahwa faktor varietas memiliki pengaruh yang sangat signifikan terhadap jumlah daun dan pengaruh yang signifikan terhadap jumlah buah dan berat buah. Varietas Bara menunjukkan kinerja adaptasi dan produktivitas terbaik dalam sistem pertanian lorong kakao, sebagaimana ditunjukkan oleh pertumbuhan vegetatif dan hasil yang lebih unggul dibandingkan varietas lain. Keunikan studi ini terletak pada penekanan bahwa pemilihan varietas merupakan faktor kunci dalam mengoptimalkan pemanfaatan ruang lorong kakao untuk budidaya lada cayenne. Temuan ini diharapkan dapat memberikan dasar ilmiah untuk pengembangan teknologi budidaya lada cayenne dalam sistem lorong kakao dan menjadi acuan untuk penelitian lebih lanjut mengenai pengembangan varietas adaptif di bawah kondisi lingkungan tersebut.

Kata Kunci : Variety, Cayenne pepper, Cocoa interrows

INTRODUCTION

In cocoa (*Theobroma cacao* L.) cultivation, the space between plant rows known as interrows is often left unused or only overgrown with weeds. In fact, these interrows have strategic potential as areas for cultivating high-economic-value intercrops, such as cayenne pepper (*Capsicum frutescens* L.), through an intercropping system (Maulana *et al.*, 2023). Optimizing the utilization of cocoa interrows not only has the potential to increase

farmers' income but also supports more efficient land use in cocoa agroforestry systems. However, the utilization of cocoa interrows at the farmer level is still not optimal, so the available economic and ecological opportunities have not been fully utilized (Ritonga *et al.*, 2023). Cayenne pepper is a crop with high economic value and consistent demand in both local and global markets. However, the development of cayenne pepper often faces various challenges such as pest and disease attacks as well as unfavorable environmental conditions.

One way to overcome these constraints is by using arbuscular mycorrhizal fungi (AMF), which have been proven to improve plant growth and yield by enhancing nutrient uptake and increasing plant tolerance to suboptimal environmental conditions (Maulana *et al.*, 2020). Cayenne pepper is a horticultural commodity with high economic value and relatively stable demand in both domestic and international markets. This crop has a relatively short harvesting cycle, making it a potential additional source of income for cocoa farmers when cultivated as an intercrop. However, the cultivation of cayenne pepper in cocoa interrows faces specific challenges compared to cultivation in open fields, particularly related to microclimatic conditions, nutrient availability, and root competition with cocoa plants (Matondang *et al.*, 2019). Based on preliminary observations in the experimental field, the growth of cayenne pepper plants cultivated in cocoa interrows showed noticeable variation among varieties. Some varieties were able to grow relatively well with more optimal branching and leaf formation, while others exhibited less vigorous growth and lower productivity.

This condition indicates that the genetic characteristics of the varieties play an important role in determining the level of adaptation of cayenne pepper plants to the specific conditions of cocoa interrows. The success of cayenne pepper cultivation in the interrow system is strongly influenced by the suitability of the varieties to the specific growing environment, such as reduced light intensity, relatively higher soil moisture, and nutrient competition with the main crop. Ritonga *et al.*, (2024) emphasized that the selection of adaptive varieties is one of the main strategies to improve plant growth and yield in intercropping systems. Varieties with high adaptability will be more efficient in utilizing the environmental resources available in cocoa interrows. Although various studies on cayenne pepper have been conducted, studies that specifically compare the responses of several cayenne pepper varieties under cocoa interrow conditions are still relatively limited. Most previous studies were conducted in open fields, and therefore do not fully represent the actual conditions of cocoa agroforestry systems (Yahya *et al.*, 2023). Therefore, this study is important to conduct in order to evaluate the differences in growth and yield responses of several cayenne pepper varieties in the cocoa interrow system.

METHOD

1. Time and Place

The research was conducted from April to July 2025 in community cocoa plantation land in Mon Jambe Village, Jeumpa District, and at the Kopbun Suka Tani Sejahtera Research and Business Center, Kota Juang District, Bireuen Regency. The research location was determined purposively because it represents cocoa interrow conditions that are commonly utilized as intercrop cultivation areas.

2. Tools and Materials

The tools used in this study included a grass cutter, machete, hoe, soil sieve, watering can, labels, stationery, plastic rope, wooden stakes, scissors, sacks, drum, camera, buckets, and an analytical balance. The materials used consisted of cayenne pepper seeds from four varieties, namely Rajo, Genie, Bara, and Tetra Hijau.

3. Experimental Design

This study used a Randomized Block Design (RBD) with one factor, namely the cayenne pepper variety. The treatments consisted of four levels: D0 = Rajo, D1 = Genie, D2 = Bara, and D3 = Tetra Hijau. Each treatment was replicated three times, resulting in 12 experimental units. If the F-test results in the analysis of variance showed a significant effect, the analysis was continued using the Honestly Significant Difference (HSD) test at the 5% significance level to determine the differences among varieties.

4. Research Implementation

The research implementation began with the preparation of cocoa interrow land through the removal of weeds and plant residues using a hoe and a grass cutter. Selected cayenne pepper seeds were first sown in nursery polybags until they were ready to be transplanted into the soil. Planting holes were made according to

the predetermined spacing, and the seedlings were then planted in each experimental plot according to the variety treatment.

Plant maintenance included watering twice a day (morning and afternoon), replanting dead or non-growing plants, weeding, installing plant stakes, and controlling plant pests and diseases mechanically. Harvesting was carried out at 68, 82, 96, and 110 days after planting (DAP), with the harvesting criterion being fruits that had turned red.

5. Data Collection Technique

The observed variables included plant height, number of leaves, number of fruits, fruit weight per plant, and fresh biomass weight. Plant height and number of leaves were measured at 15, 30, and 45 days after planting (DAP) using a measuring tape. The number of fruits and fruit weight were recorded during harvest at 68, 82, 96, and 110 DAP using an analytical balance. The fresh biomass weight was measured after the plants were uprooted and cleaned. All data were recorded systematically for each experimental unit.

6. Data Analysis Techniques

The observational data were analyzed quantitatively using analysis of variance (ANOVA) based on the Randomized Block Design (RBD) method at a 5% significance level to test the effect of varietal differences. If the F-test showed a significant difference, the analysis was continued using the Honestly Significant Difference (HSD) test at the 5% significance level to determine the differences among varieties.

RESULTS AND DISCUSSION

This study showed differences in the growth responses of cayenne pepper plants (*Capsicum frutescens* L.) grown in cocoa (*Theobroma cacao* L.) interrows. The observations were carried out on several parameters, namely plant height, number of leaves, number of fruits, fruit weight, and fresh biomass weight.

1. Plant Height

The results of the F-test in the analysis of variance showed that the variety factor had no significant effect on the plant height of cayenne pepper at 15 and 45 days after planting (DAP). However, at 30 DAP, the F-test results indicated that the variety factor had a significant effect on plant height. The average plant height of cayenne pepper at 15, 30, and 45 DAP under different variety treatments can be seen in Table 1.

Table 1. Average plant height at 15, 30, and 45 days after planting (DAP) under different cayenne pepper variety treatments.

Chili Varieties	Plant Height		
	15 Hst	30 Hst	45 Hst
Rajo	20,25	27,00ab	41,13
Genie	21,13	28,13abc	37,69
Bara	23,13	30,75abcd	41,44
Tetra Hijau	20,88	24,13 a	35,25
BNJ 0,05		7,98	

Information: Numbers followed by the same letter in the same column are not significantly different at the 5% level (Uji BNJ_{0,05})

Based on Table 1, at 15 days after planting (DAP), the Rajo variety had a plant height of 20.25 cm, while the Genie variety was slightly taller at 21.13 cm. The Bara variety showed the highest growth at 23.13 cm, whereas the Tetra Hijau variety reached 20.88 cm. These differences indicate variations in the early adaptation ability among varieties in utilizing nutrients and the environmental conditions of cocoa interrows. According to Sutopo *et al.*, (2021), differences in plant height among cayenne pepper varieties occur due to variations in genetic potential that influence stem growth rate and leaf size development during the vegetative stage. In addition, Nuraini and Lestari (2022) stated that varieties with good growth performance usually have faster stem growth

due to a higher rate of cell division in the meristematic tissue. This supports the finding that varieties with better genetic responses tend to exhibit faster early growth during the vegetative phase.

At 30 days after planting (DAP), the Rajo variety reached a height of 27.00 cm, the Genie variety 28.13 cm, and the Bara variety again showed the greatest height at 30.75 cm, while the Tetra Hijau variety reached only 24.13 cm. These results confirm that the ability to utilize nutrients and water differs among varieties. This finding is consistent with the study of Rahayu *et al.*, (2023), which stated that cayenne pepper varieties have a significant effect on plant height at certain growth stages, particularly during the active growth phase around 30 days after planting. At 45 DAP, the Rajo variety had a height of 41.13 cm, the Genie variety 37.69 cm, the Bara variety remained the tallest at 41.44 cm, and the Tetra Hijau variety was the lowest at 35.25 cm. These differences indicate the influence of varietal adaptability during the later vegetative stage in the cocoa interrow environment. These results are supported by Anwar *et al.*, (2023), who reported that varieties with a more extensive root system have better capacity for water and nutrient absorption in limited environments such as cocoa interrows.

2. Number of Leaves

The results of the F-test in the analysis of variance showed that the variety factor had a highly significant effect on the number of leaves of cayenne pepper at 15, 30, and 45 days after planting (DAP). The average number of leaves of cayenne pepper at 15, 30, and 45 DAP under different variety treatments can be seen in Table 10.

Table 2. Average number of leaves at 15, 30, and 45 days after planting (DAP) under different cayenne pepper variety treatments.

Chili Varieties	Number of Leaves		
	15 Hst	30 Hst	45 Hst
Rajo	7,44a	12,94a	34,94a
Genie	12,06bc	25,56c	85,63bcd
Bara	13,00bcd	25,63cd	84,50bc
Tetra Hijau	11,31b	17,25b	66,56ab
BNJ 0,05	3,73	13,16	39,25

Information : Numbers followed by the same letter in the same column indicate no significant difference at the 5% level (Uji BNJ_{0,05})

Based on Table 2, at 15 days after planting (DAP), the Rajo variety produced 7.44 leaves, the Genie variety 12.06 leaves, the Bara variety showed the highest number with 13.00 leaves, and the Tetra Hijau variety produced 11.31 leaves. These differences indicate variations in the initial ability of the varieties to form vegetative organs under cocoa interrow conditions. According to Ardiansyah *et al.*, (2020), differences in the number of leaves among cayenne pepper varieties are influenced by genetic factors that play a role in the plant's ability to produce new shoots and leaves. At 30 DAP, the Rajo variety had 12.94 leaves, the Genie variety increased significantly to 25.56 leaves, the Bara variety reached 25.63 leaves, and the Tetra Hijau variety had 17.25 leaves. These results indicate that the Genie and Bara varieties were more capable of utilizing nitrogen and phosphorus during the active vegetative phase (Maulana *et al.*, 2024). In addition, Hidayat *et al.*, (2023) stated that varieties that are able to adapt well to their environment can maintain optimal vegetative growth, resulting in a higher number of leaves compared to other varieties.

At 45 days after planting (DAP), the Rajo variety produced 34.94 leaves, the Genie variety showed the highest number with 85.63 leaves, the Bara variety produced 84.50 leaves, and the Tetra Hijau variety produced 66.56 leaves. These differences confirm that genetic adaptability plays an important role in determining the continuity of leaf growth during the later vegetative stage. Yuliana and Prasetyo (2022) also stated that each cayenne pepper variety has a different vegetative growth rate, depending on the genetic ability of each variety to utilize nutrients and water in the growing medium. In general, the higher number of leaves in the Genie and Bara varieties indicates better adaptability under the humid and partially shaded conditions of cocoa interrows. This is supported by Rahmadi and Putra (2023), who reported that an increase in leaf number is closely related to the

balance between nitrogen availability and soil water availability. Therefore, a humid environment rich in organic matter from cocoa leaves supports the formation of new leaves.

3. Number of Fruits

The results of the F-test in the analysis of variance showed that the variety factor had a highly significant effect on the number of fruits at 110 days after planting (DAP). The average number of cayenne pepper fruits at 110 DAP under different variety treatments can be seen in Table 3.

Table 3. Average number of fruits at 110 days after planting (DAP) under different cayenne pepper variety treatments.

Chili Varieties	Number of Fruits
	110 Hst
Rajo	10,56a
Genie	18,38b
Bara	21,25bcd
Tetra Hijau	19,50bc
BNJ 0,05	7,38

Information : Numbers followed by the same letter in the same column indicate no significant difference at the 5% level (Uji BNJ_{0,05})

Based on Table 3, in the observation of fruit number, the Rajo variety produced 10.56 fruits. This relatively low number of fruits is caused by the genetic characteristics of the Rajo variety, which has a limited ability to produce flowers and fruits. Under cocoa interrow conditions, competition for nutrients and water causes the distribution of photosynthates to be more focused on maintaining vegetative growth, so the formation and development of fruits cannot occur optimally. Meanwhile, the Genie variety produced 18.38 fruits, which is higher than the Rajo variety. This is due to the ability of the Genie variety to produce more branches and leaves, thereby increasing photosynthetic capacity and supporting higher flower and fruit formation under cocoa interrow conditions. The results of this study are also consistent with the findings of Hidayati *et al.*, (2020), who stated that varietal differences influence the number and weight of chili fruits because each variety has different adaptability and yield potential under specific environmental conditions.

The Bara variety produced the highest number of fruits, reaching 21.25 fruits per plant. This higher fruit number is related to the genetic characteristics of the Bara variety, which has a high generative potential and the ability to utilize soil nutrients efficiently in the cocoa interrow system. A greater number of branches and leaves increases the availability of photosynthates that play an important role in fruit formation and development. This condition indicates that varieties with better vegetative growth tend to have a higher fruit production capacity compared to other varieties under the same growing environment. The Tetra Hijau variety produced 19.50 fruits per plant, which is higher than the Genie variety but still lower than the Bara variety. This condition indicates that the Tetra Hijau variety has fairly good fruit formation potential in cocoa interrows, although the efficiency of nutrient and photosynthate utilization is not as optimal as that of the Bara variety. According to Aminah *et al.*, (2021), differences in fruit number in chili plants can be caused by genetic differences among varieties that determine the number of flowers and the plant's ability to retain fruit set until harvest.

In addition, Sari and Prasetyo (2022) reported that chili varieties with better vegetative growth tend to produce a higher number of fruits because the plants are able to support the optimal development of generative organs. Putri and Rahmadani (2025) stated that optimal phosphorus absorption increases flower formation and prolongs fruit development, especially in soils rich in organic matter such as cocoa interrows, which usually receive leaf litter from shade trees. This is consistent with the findings of Halim *et al.*, (2023), who reported that in agroforestry systems, chili varieties with more branching and an open canopy tend to produce more fruits because of better light interception even under partial shade conditions. Yunita and Darsono (2024) explained that varieties that are less adaptive to agroforestry environments tend to experience delayed flowering and reduced fruit set due to disruptions in pollination and seed formation processes caused by high humidity.

4. Fruit Weight

The results of the F-test in the analysis of variance showed that the variety factor had a highly significant effect on fruit weight at 110 days after planting (DAP). The average fruit weight of cayenne pepper at 110 DAP under different variety treatments can be seen in Table.

Table 4. Average fruit weight at 110 days after planting (DAP) under different cayenne pepper variety treatments.

Chili Varieties	Fruit Weight (g)
	110 Hst
Rajo	7,55a
Genie	15,32bc
Bara	17,54bcd
Tetra Hijau	14,21ab
BNJ 0,05	6,80

Keterangan : Numbers followed by the same letter in the same column indicate no significant difference at the 5% level (Uji BNJ_{0,05})

Based on Table 4, in the observation of fruit weight, the Rajo variety produced a fruit weight of 7.55 g. This relatively low fruit weight is related to the genetic characteristics of the Rajo variety, which tends to produce fruits with smaller size and weight. Under cocoa interrow conditions, limited nutrient absorption and the distribution of photosynthates cause fruit filling to be less optimal, resulting in lower fruit weight compared to other cayenne pepper varieties (Maulana *et al.*, 2022). The Genie variety showed a fruit weight of 15.32 g, which is higher than that of the Rajo variety. This condition indicates that the Genie variety has better fruit filling ability, supported by higher photosynthetic capacity and more efficient assimilate distribution in the cocoa interrow environment. The Bara variety produced the highest fruit weight of 17.54 g.

This higher fruit weight is related to the genetic characteristics of the Bara variety, which is capable of producing fruits with larger size and weight. Under cocoa interrow conditions, this variety is able to utilize soil nutrients optimally to support fruit formation and filling. This condition indicates that varieties with superior genetic potential are able to produce better yields even under the same growing environment. The Tetra Hijau variety produced a fruit weight of 14.21 g. This result is lower than that of the Bara variety but still higher than that of the Rajo variety. This condition indicates that the Tetra Hijau variety has fairly good fruit filling potential in cocoa interrows, although the efficiency of nutrient and photosynthate utilization is not as optimal as that of the Bara variety. In addition, Hapsari *et al.*, (2022) stated that differences in fruit weight among chili varieties are closely related to genetic potential and the level of plant adaptation to their growing environment. Varieties with better adaptability are able to utilize nutrients more efficiently, resulting in heavier fruit weight.

This finding is consistent with the results of Kurniawan *et al.*, (2023), who stated that chili varieties with a strong vascular system are able to increase the efficiency of carbohydrate translocation from leaves to fruits, resulting in greater fruit weight. In addition to physiological factors, the ability to adapt to the cocoa interrow environment also plays an important role. Handoko and Wiranata (2025) found that chili varieties capable of tolerating high humidity and moderate light conditions generally produce heavier fruits because the processes of cell formation and fruit filling occur more optimally. The soil conditions in cocoa interrows, which are rich in organic matter, also help provide essential micronutrients required for cell wall formation in fruits.

5. Fresh Biomass Weight

The results of the F-test in the analysis of variance showed that the variety factor had no significant effect on the fresh biomass weight per plant at 110 days after planting (DAP). The average fresh biomass weight of cayenne pepper at 110 DAP under different variety treatments can be seen in Table 5.

Table 5. Average fresh biomass weight at 110 days after planting (DAP) under different cayenne pepper variety treatments.

Chili Varieties	Fresh Biomass Weight (g)
	110 Hst

Rajo	29,38
Genie	21,19
Bara	19,63
Tetra Hijau	20,13

Based on Table 5, at 110 days after planting (DAP), the Rajo variety produced a fresh biomass weight of 29.38 g, which was the highest among all observed varieties. The higher biomass weight is related to the ability of the Rajo variety to produce greater vegetative biomass under cocoa interrow conditions. A larger canopy growth indicates that this variety is able to utilize nutrients and water more effectively to support the formation of vegetative tissues. The Genie variety showed a fresh biomass weight of 21.19 g. This result is lower than that of the Rajo variety, indicating that vegetative biomass accumulation in the Genie variety occurs at a moderate level. This condition is related to the relatively balanced distribution of photosynthates between vegetative and generative growth in the cocoa interrow environment.

The Bara variety produced a fresh biomass weight of 19.63 g. The lower biomass weight is associated with the characteristics of the Bara variety, which tends to allocate a larger portion of photosynthetic products to the formation of generative organs. The Tetra Hijau variety showed a fresh biomass weight of 20.13 g. Although slightly higher than Bara, it is still lower than Rajo. This condition indicates that the Tetra Hijau variety has a fairly good ability to produce vegetative biomass in cocoa interrows, although the efficiency of nutrient utilization is not as optimal as that of the Rajo variety. According to Khandaker *et al.*, (2020), chili varieties that have good adaptability to intercropping conditions are able to maintain higher photosynthetic rates and better vegetative growth compared to less adaptive varieties. Subedi *et al.*, (2023) also stated that the influence of variety on chili growth and yield will be more clearly observed when there is a strong interaction with environmental conditions, such as nitrogen availability and microbial activity in the soil. The combination of adaptable varieties and the use of mycorrhiza can increase nutrient uptake efficiency in cropping systems under perennial plant stands such as cocoa (Maulana *et al.*, 2025).

CONCLUSION

Based on the results of the study on the effect of varietal differences on the growth and yield of cayenne pepper (*Capsicum frutescens* L.) grown in cocoa interrows, several conclusions can be drawn as follows:

The variety factor had a significant effect on plant height at 30 days after planting (DAP), but it did not show a significant effect at 15 and 45 DAP. The number of leaves parameter at 15, 30, and 45 DAP showed a highly significant effect, where the Bara and Genie varieties produced the highest number of leaves compared to the other varieties. The variety factor also had a significant effect on the number of fruits and fruit weight at 110 DAP, where the Bara variety produced the highest results for both parameters. Meanwhile, the number of branches, fresh biomass weight, and root weight among the varieties did not show a significant effect.

REFERENCES

- Aminah, S., Lestari, N., & Rahmadani, R. (2021). *Growth and Yield of Several Bird's Eye Chili Varieties (Capsicum frutescens L.) on Dry Land*. *Agrotek Tropika Journal*, 9(3), 122–129.
- Anwar, L., Putri, M., & Rahmawati, D. (2023). *Physiological and Root Morphometric Responses of Several Chili Varieties to Limited Growing Space Conditions under Cocoa Stands*. *Agroekoteknologi Lestari Journal*, 10(1), 44–52.
- Ardiansyah, M., Suryanto, A., & Rini, D. (2020). *Diversity of Vegetative Growth of Several Bird's Eye Chili Varieties (Capsicum frutescens L.) in Lowland Areas*. *Agroteknologi Tropika Journal*, 8(2), 72–80.
- Halim, S., Nurbaiti, A., & Fathurrahman, I. (2023). *Effect of Branching and Canopy Shape on Chili Fruit Yield in an Agroforestry System*. *Indonesian Journal of Applied Horticulture*, 11(2), 91–101.
- Handoko, A., & Wiranata, D. (2025). *Tolerance of Chili Varieties to High Humidity and Its Effect on Fruit Size under Cocoa Stands*. *Integrated Agroforestry Journal*, 12(2), 78–89.

- Hapsari, D., Kurniawati, R., & Nugraha, A. (2022). *Evaluation of Several Chili Varieties on Yield and Fruit Quality in Lowland Areas*. Indonesian Journal of Agricultural Science, 27(2), 133–140.
- Hidayat, R., Kurniawan, B., & Setiawan, T. (2023). *Growth Performance and Yield of Several Bird's Eye Chili Varieties in Different Growing Environments*. Indonesian Journal of Agricultural Science. 15(1), 55–63.
- Hidayati, N., Nasution, A., & Rahman, M. (2020). *Response of Several Chili Varieties to Growth and Yield under Different Environmental Conditions*. Indonesian Journal of Horticulture, 11(2), 87–94.
- Kapoulas, N., Ilić, Z. S., & Koukounaras, A. (2020). *Effect of Arbuscular Mycorrhizal Application in Greenhouse Soil on the Yield of Organic Chili Plants*. International Journal of Horticultural Science, 18(1), 73–82.
- Khandaker, M. M., Rohani, F., & Dalorima, T. (2020). *Effect of Various Types of Organic Fertilizers on Growth, Yield, and Quality of Red Chili 'Kulai' Variety (Capsicum annum L.)*. Asian Journal of Biotechnology, 14(1), 115–124.
- Kurniawan, T., Puspitasari, D., & Nugroho, R. (2023). *Carbohydrate Translocation Efficiency and Its Effect on Fruit Weight Increase of Several Chili Varieties*. Indonesian Journal of Plant Physiology and Production, 15(3), 133–145.
- Matondang, A., Siregar, R., & Lubis, M. (2019). *Adaptation of Bird's Eye Chili Plants in an Intercropping System with Cocoa*. Tropical Horticulture Journal, 14(2), 85–93.
- Maulana, M. (2020). *rowth of Several Chili Varieties (Capsicum annum L.) Due to Mycorrhizal Application in Saline Soil*. Fanik : Journal Faperta Uniki, 1(1), 9-16.
- Maulana, M., & Harahap, D. E. (2023). *Increase in Okra Production Due to the Application of Various Types of Mycorrhiza and Rock Phosphate Doses in Saline Soil*. Journal of Agro-Livestock (JAL), 1(01), 14-26.
- Maulana, M., & Noer, Z. (2025). *Evaluation of Several Chili Varieties on Yield and Fruit Quality in Lowland Areas*. Indonesian Journal of Agricultural Science, 7 (3), 967-972.
- Maulana, M., Pratiwi, V., Harta, R. Y., Ritaqwin, Z., & Harahap, D. E. (2024). *Production of Okra (Abelmoschus esculentus L. Moench) as Affected by the Application of Mycorrhiza and Rock Phosphate Fertilizer under Salinity Stress*. Journal of Indonesian Agricultural Science, 29(4), 533-540.
- Maulana, M., Ritaqwin, Z., & Mawaddah, F. (2022). *Growth and Colonization of Mycorrhizal Fungi under Saline Soil Stress on Chili Plants*. Viabel: Scientific Journal of Agricultural Sciences, 16 (1), 1-12.
- Nuraini, S., & Lestari, D. (2022). *Effect of Varieties on the Vegetative Growth of Chili Plants (Capsicum frutescens L.) in Dryland Areas*. Journal of Tropical Agrotechnology, 10(1), 51–58.
- Putri, M. D., & Rahmadani, E. (2025). *Role of Phosphorus and Mycorrhiza in Flower Formation and Fruit Development of Chili Plants in Shaded Environments*. Journal of Tropical Agrophysiology, 13(1), 110–122.
- Rahayu, F., Handoko, P., & Sari, M. (2023). *Growth Response of Several Chili Varieties to Different Environmental Conditions*. Journal of Applied Agricultural Science, 12(2), 102–110.
- Rahmadi, A., & Putra, F. R. (2023). *Relationship between Nitrogen Supply, Soil Moisture, and Leaf Formation of Chili Pepper in a Mixed Farming System*. Indonesian Journal of Agroecology, 12(3), 101–110.
- Ritonga, D., Harahap, F., & Nasution, H. (2023). *Optimization of Cocoa Shade Management to Increase Farmers' Income*. Indonesian Journal of Agroforestry, 8 (1), 45–54.
- Ritonga, D., Harahap, F., & Nasution, H. (2024). *The Role of Variety Selection in Improving Crop Productivity in Intercropping Systems*. Journal of Sustainable Agricultural Science, 9(1), 12–21.
- Sari, R. D., & Prasetyo, D. (2020). *Effect of Varieties on the Growth and Yield of Red Chili (Capsicum annum L.)*. Indonesian Journal of Agricultural Science, 27(1), 45–52.
- Subedi, P., Bhattarai, P., Lamichhane, B., & Khanal, A. (2023). *Effect of Different Levels of Nitrogen and Charcoal on Growth and Yield of Chili (Capsicum annum L.)*. Journal of Agricultural Science (Heliyon), 9(2).
- Sutopo, A., Dewi, N., & Kurniawan, R. (2021). *Growth Character Differences of Several Chili Varieties (Capsicum spp.) at the Vegetative Stage*. Indonesian Journal of Horticulture, 17(3), 133–142.
- Yahya, M., Putra, A., & Rahman, S. (2023). *Evaluation of Chili Pepper Growth under Various Land Conditions*. Journal of Crop Production, 11(3), 120–128.
- Yuliana, D., & Prasetyo, A. (2022). *Vegetative Growth of Various Chili Varieties in Different Growing Media*. Tropical Horticulture Journal, 12(3), 145–153.
- Yunita, D., & Darsono, A. (2024). *Physiological Response of Several Chili Varieties to Agroforestry Cocoa Microclimate Conditions*. Tropical Journal of Sustainable Agriculture, 10(3), 121–130.