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IMPLEMENTATION OF DRIP IRRIGATION ON THE GROWTH OF PAGODA MUSTARD (*Brassica narinosa* L.)

Implementasi Penerapan Irigasi Tetes pada Pertumbuhan Sawi Pagoda (*Brassica narinosa* L.)

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Abstract. Drip irrigation has been applied as an alternative irrigation technology for cultivating pagoda mustard in arid areas. This study aimed to evaluate the effects of different drip irrigation frequencies on the growth of pagoda mustard (*Brassica narinosa* L.). The experiment was conducted from September to December 2024 at the Agrotechnology Experimental Field, Faculty of Science and Technology, University of Darussalam Gontor. Four irrigation treatments were applied: conventional surface watering (control), drip irrigation once per day, drip irrigation twice per day, and drip irrigation three times per day. Each treatment was replicated three times. Observed parameters included microclimatic conditions and plant growth variables. Data were analyzed using analysis of variance (ANOVA), followed by the Least Significant Difference (LSD) test at the 5% significance level when significant differences were detected, using RStudio software. The results showed that drip irrigation was able to meet the water requirements for pagoda mustard growth. No significant differences were observed in root and shoot growth among treatments; however, drip irrigation applied three times per day enhanced shoot canopy growth compared to lower irrigation frequencies.
Keywords: Agrotechnology, Drip Irrigation, Innovation, Pagoda Mustard**.**

Abstract. Irigasi tetes telah diterapkan sebagai teknologi irigasi alternatif untuk budidaya sawi pagoda di daerah kering. Penelitian ini bertujuan untuk mengevaluasi pengaruh perbedaan frekuensi irigasi tetes terhadap pertumbuhan tanaman sawi pagoda (Brassica narinosa L.). Penelitian dilaksanakan pada bulan September hingga Desember 2024 di Kebun Percobaan Agroteknologi, Fakultas Sains dan Teknologi, Universitas Darussalam Gontor. Empat perlakuan irigasi diterapkan, yaitu penyiraman permukaan secara konvensional (kontrol), irigasi tetes satu kali per hari, irigasi tetes dua kali per hari, dan irigasi tetes tiga kali per hari. Setiap perlakuan diulang sebanyak tiga kali. Parameter yang diamati meliputi kondisi mikroklimat dan variabel pertumbuhan tanaman. Data dianalisis menggunakan analisis ragam (ANOVA) dan dilanjutkan dengan uji Beda Nyata Terkecil (BNT) pada taraf 5% apabila terdapat perbedaan nyata, menggunakan perangkat lunak RStudio. Hasil penelitian menunjukkan bahwa irigasi tetes mampu memenuhi kebutuhan air untuk pertumbuhan sawi pagoda. Tidak terdapat perbedaan nyata pada pertumbuhan akar dan tajuk antar perlakuan, namun irigasi tetes tiga kali per hari mampu meningkatkan pertumbuhan tajuk tanaman dibandingkan frekuensi irigasi yang lebih rendah.

Kata Kunci: Agroteknologi, irigasi tetes, inovasi, sawi pagoda

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INTRODUCTION

Pagoda mustard (*Brassica narinosa* L.) is a vegetable that has become increasingly popular among the public. This plant is characterized by its attractive dark green leaves, which can be consumed either raw or processed, and is known for its high nutritional value (Saputra *et al*., 2022). Per 100 grams of pagoda mustard, the nutritional compotition includes vitamin A (1,940 mg), calcium (Ca) (220 mg), and vitamin C (102 mg). Originating from China, this plant has considerable potential for cultivation in Indonesia. Mustard greens thrive in highland areas with fertile and moist soil (Haryanto *et al*., 2003). Pagoda mustard is a relatively new variety in Indonesia and is commonly consumed as a salad or cooked vegetable. Its growing popularity reflects increasing public awareness of the importance of maintaining health and consuming green vegetables. Consequently, the market prospects of pagoda mustard in the food industry represent a promising business opportunity in Indonesia (Sajali & Khoiriah, 2023). Furthermore, pagoda mustard contains beneficial nutritional compounds, including alkaloids, potassium, and iodine, which contribute to human health (Jayati & Susanti, 2019).

There has been limited research on pagoda mustard plants, particularly regarding their ability to grow under diverse environmental conditions. In general, pagoda mustard is cultivated using hydroponic systems; however, this does not preclude the possibility of cultivation on suboptimal land. One of the major types of suboptimal land in Indonesia is dry land, which is further challenged by unpredictable climate change. In 2014, dry land in Indonesia was recorded at 144.47 million hectares, of which approximately 82% was classified as suboptimal. This category is divided into acidic dry land and dry-climate dry land (Priyanto, 2022).

Irrigation technology plays a vital role in dryland agriculture. In this context, irrigation refers to the practice of supplying water to land in order to meet plant water requirements. It is expected to be applied effectively and efficiently to optimize plant growth. In arid regions, one of the most effective irrigation technologies is drip irrigation. This system consistently meets plant water needs while minimizing water losses caused by runoff, percolation, evaporation, and transpiration. With these advantages, drip irrigation can alleviate drought stress and accelerate plant adaptation to growth conditions, even in arid environments (Sunik *et al*., 2023). The benefits of drip irrigation are further supported by research conducted by Mustawa *et al.* (2017), which demonstrated that its application across various soil textures for mustard plants yielded efficient results. This irrigation system not only enhances mustard plant productivity but also provides insights into its effectiveness across different soil types. These findings indicate that drip irrigation is beneficial not only in arid regions but can also be adapted to diverse soil conditions to improve agricultural yields.

Water plays a crucial role in the composition of plant tissues. Pagoda mustard plants are herbaceous species with succulent stems and are harvested fresh during the vegetative stage.

Consequently, the availability and adequacy of water during the growth period strongly influence both the biological performance and the commercial viability of mustard plants. Plants subjected to limited irrigation exhibit different morphological growth compared to those provided with sufficient irrigation, in accordance with their physiological requirements. Therefore, it is essential to ensure adequate water supply by adjusting the frequency of irrigation through drip irrigation techniques. This method helps conserve water by minimizing losses due to runoff, seepage, and evaporation. The present study aims to evaluate the effect of drip irrigation on the growth of pagoda mustard plants.

MATERIALS AND METHODS

The research was conducted from August to December 2024 at the Agrotechnology Experimental Field, Faculty of Science and Technology, University of Darussalam Gontor. The materials and equipment used included polybags, a drip irrigation system, pagoda mustard seeds, compost fertilizer, a digital balance, an oven, and supporting laboratory and office supplies. The experiment was arranged in a Completely Randomized Design (CRD) with a single treatment factor. The treatment factor consisted of four levels: 1. Surface watering irrigation (S), 2. Drip irrigation once per day (D1), 3. Drip irrigation twice per day (D2), 4. Drip irrigation three times per day (D3). Each treatment was replicated three times. In the control treatment, irrigation was applied manually to the soil surface until field capacity was reached. Field capacity was determined prior to the experiment and measured at 100 mL per polybag. For the drip irrigation treatments, the emitter discharge rate was calculated through pre-experiment and was found to require approximately 10 minutes to deliver 100 mL per polybag. The drip irrigation system was equipped with an automatic timer capable of maintaining the programmed schedule during power interruptions. In addition, the water pump was fitted with a filter to ensure that the supplied water was free from impurities. Accordingly, the stop valve was opened, and the irrigation timer was set to operate for 10 minutes per irrigation event.

As illustrated in Figure 1, the drip irrigation system consisted of a water reservoir, a water pump, and an automatic timer connected to a network of irrigation tubing. To ensure uniform water distribution from the points closest to the water source to the farthest emitters, the tubing diameter was gradually reduced, using 7 mm tubing near the stop valves, 5 mm tubing for each treatment line, and 3 mm tubing for individual drip emitters. This gradual reduction in tubing diameter facilitated a more even distribution of water discharge across all drip points. The automatic timer regulated the irrigation schedule, while stop valves were used to control the wateringfrequency for each treatment. Treatment D1 involved opening the stop valve once per day. Treatment D2 involved opening the valve twice per day (morning and evening) and treatment D3 involved opening the valve three times per day (morning, afternoon and evening). Treatment S served as the control, in which plants were watered manually using conventional surface irrigation methods drip irrigation.

Microclimatic parameters observed included light intensity (lux), daily air temperature (°C), and relative humidity (%). Plant growth parameters measured were plant height (cm), number of leaves, leaf width (cm), main stem diameter (cm), fresh shoot weight (g), and fresh root weight (g). Both microclimate and plant growth data were collected throughout the experiment. Raw data obtained from each observation parameter were subjected to statistical analysis using Analysis of Variance (ANOVA). When a significant treatment effect was detected, mean comparisons were performed using the Least Significant Difference (LSD) test at the 5% significance level. All statistical analyses were conducted using RStudio software.

Fig 1. Drip Irrigation System (Personal Documentation)

RESULTS AND DISCUSSION

Microclimate conditions

The recorded data were averaged to obtain daily values of light intensity, humidity, and air temperature in the pagoda mustard growing environment. Figure 2. Illustrates the microclimatic conditions inside the greenhouse during the experimental period. The results of climate observations show that seasonal variations between dry and rainy periods resulted in changes in average daily temperature, humidity, and light intensity. When light intensity is high, air temperature increases, and humidity decreases. Conversely, when light intensity is low, air temperature decreases, while humidity increases. Pagoda mustard can grow well in both lowland and highland areas. These conditions are generally suitable for pagoda mustard cultivation, which can adapt to a wide range of environmental conditions in both lowland and highland areas and can be harvested within 40 – 45 days (Guntara et al., 2021). Importantly, the recorded microclimatic conditions remained within the tolerance range of pagoda mustard throughout the growing period. This indicates that the plant growth responses observed in this study were predominantly driven by differences in water availability associated with the drip irrigation treatments, rather than by environmental stress factors. Figure 2 presents the microclimatic conditions during the growing season of pagoda mustard. Drip irrigation plays a critical role in maintaining stable soil moisture, particularly under fluctuating temperature and light intensity. According to Dewi et al., (2020) climatic parameters directly influence evapotranspiration rates, highlighting the importance of microclimate management in controlled cultivation systems. Therefore, microclimate observations provide an essential basis for interpreting the effects of drip irrigation frequency on the growth and yield of pagoda mustard.

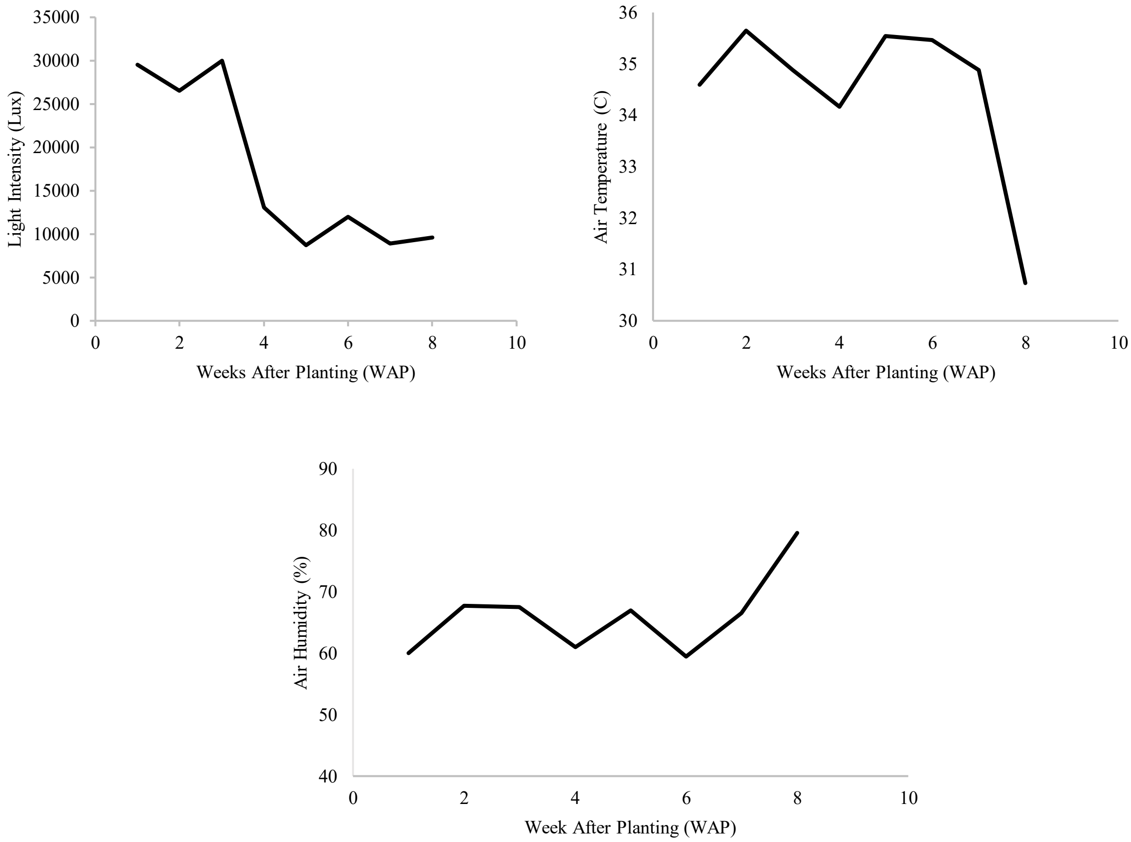

Fig. 2: Microclimate During the Growing Season of Pagoda Mustard

Plant Growth

The root-shoot ratio is a parameter used to evaluate the balance between root and shoot growth in response to different irrigation treatments. Under drought conditions, root growth tends to be more dominant than shoot growth as an adaptive strategy to access limited water resources. Water plays a crucial role in the plant growth process, particularly in soft-stemmed crops such as pagoda mustard. Nugroho and Setiawan (2022), reported that mustard plants receiving higher water supply exhibited greater shoot (canopy) growth compared to plants experiencing drought stress.

The results of this study showed that increasing irrigation frequency tended to enhance canopy growth (Table 1), while root growth remained relatively similar across all treatments. This indicates that water availability in the root zone was sufficient, eliminating the need for plants to extend their root systems in search of water. The application of drip irrigation ensures that water is supplied directly to the root zone, thereby reducing water loss through evaporation and improving water use efficiency (Steven Witman, 2021). Consequently, variations in drip irrigation frequency (once, twice, or three times per day) did not result in significant differences in the root–shoot ratio of pagoda mustard compared to the control treatment.

Table 1. Mean plant height, root length, and root: ratio of Pagoda mustard plants

Treatments	Plant Height (cm)	Root Length (cm)	Root:Shoot Ratio
Watering	10.61 b	10.56 a	1.05 ab
Drip once per day	10.58 b	13.00 a	1.23 a
Drip twice per day	11.05 ab	13.05 a	1.36 a
Drip three times per day	13.21 a	9.95 a	0.76 b

Note: The same letter in the numbers is not significantly different in the LSD test.

Table 2 shows that the treatments had no significant effect on stem diameter or shoot canopy. Drip irrigation delivers water in a controlled and localized manner through a system that functions as a temporary reservoir. This system is equipped with small outlets that allow to drip slowly into the soil, gradually wetting the root zone around the plant. The arrangement of these drip outlets is designed to ensure that water application is efficient and sufficient to meet soil moisture requirements in the vicinity of the plant (Witman, 2021).

Table 2. Mean stem diameter and shoot canopy width of Pagoda mustard plants

Treatments	Stem Diameter (cm)	Shoot Canopy (cm)
Watering	0.60 a	21.61 a
Drip once per day	0.58 a	21.30 a
Drip twice per day	0.61 a	21.16 a
Drip three times per day	0.65 a	20.00 a

Note: The same letter in the numbers is not significantly different in the LSD test.

Drip irrigation influences soil moisture content, which directly affects plant water status. Adequate water availability in the growing medium maintains cell turgor, thereby increasing plant fresh weight (Marzukoh et al., 2013). Water is required in large quantities for plant physiological processes, particularly photosynthesis. In higher plants, approximately 85–90% of the fresh weight of cells and tissues consists of water. Water functions as a solvent for nutrients, a major component of protoplasm, and a key reactant in photosynthesis, in addition to its other essential roles (Kurniawan *et al*., 2014). Sufficient water availability maintains turgor pressure and promotes stomatal opening, enabling optimal CO_2 uptake and photosynthetic rates (Yi et al., 2022). Given that pagoda mustard is harvested as a fresh vegetable, fresh shoot biomass is an important indicator of both biological performance and economic value.

Table 3 shows that drip irrigation applied once per day significantly reduced fresh shoot weight compared to manual watering. However, increasing drip irrigation frequency resulted in higher fresh shoot weight, approaching that of the control treatment. Although the twice-daily and three-times-daily drip irrigation treatments did not differ significantly from the control, manual watering numerically produced the highest fresh biomass. This suggests that manual watering may have supplied a greater total volume of water, thereby enhancing water availability for biomass accumulation. Overall, these findings indicate that drip irrigation is effective in maintaining normal growth of pagoda mustard; however, optimization of irrigation frequency and water volume is required for yields to match or exceed those achieved with manual watering. Consistent with the findings of Za et al., (2026), irrigation applied five times per day at 45-minute intervals was reported to be optimal for improving growth and yield in cucumber plants. Thus, appropriate regulation of irrigation frequency and water volume is a critical factor in enhancing water use efficiency while maximizing productivity in horticultural crops.

Table 3. Mean shoot fresh weight and root fresh weight of Pagoda mustard plants

Treatments	Shoot Fresh Weight (g)	Root Fresh Weight (g)
Watering	49.48 a	2.40 a
Drip once per day	32.19 b	1.99 a
Drip twice per day	35.50 ab	2.71 a
Drip three times per day	36.46 ab	2.33 a

Note: The same letter in the numbers is not significantly different in the LSD test.

CONCLUSION

Based on the results of this study, drip irrigation was as effective as conventional watering in supporting plant growth. Although the control treatment numerically produced the highest fresh biomass, increasing the frequency of drip irrigation resulted in plant growth comparable to that of the control. Therefore, drip irrigation may serve as an alternative irrigation method for achieving comparable growth performance to conventional watering in pagoda mustard cultivation.

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REFERENCES

Guntara, R., Isnaeni, S., & Rosmala, A. (2021). Growth and yield of pagoda (*Brassica narinosa* L) with concentration and watering interval of fermented rabbit urine on hydroponic system. *IOP Conference Series: Earth and Environmental Science*, *672*(1). https://doi.org/10.1088/1755-1315/672/1/012100

Haryanto, E., Suhartini, T., Rahayu, E., & Sunarjono, D. H. H. (2003). *Sawi dan Selada*. Penebar Swadaya.

Jayati, R. D., & Susanti, I. (2019). Perbedaan Pertumbuhan Dan Produktivitas Tanaman Sawi Pagoda Menggunakan Pupuk Organik Cair Dari Eceng Gondok Dan Limbah Sayur. *Jurnal Biosilampari : Jurnal Biologi*, *1*(2), 73–77. https://doi.org/10.31540/biosilampari.v1i2.246

Kurniawan, B. A., Fajriani, S., & Ariffin. (2014). The Effect Of Giving Water Levels To Response Of The Growth And Yield For Tobacco (*Nicotiana tabaccum* L.). *Produksi Tanaman*, *2*(1), 59–64.

Marzukoh, R. U., Sakya, A. T., & Rahayu, M. (2013). Pengaruh Volume

Pemberian Air terhadap Pertumbuhan Tiga Varietas Tomat (Lycopersicum esculentum Mill). *Agrosains: Jurnal Penelitian Agronomi*, *15*(1), 12. https://doi.org/10.20961/agsjpa.v15i1.18986

Dewi, A. V. K., Setiawan, B. I., Santoso, R., & Waspodo, B. (2020). Microclimate Condition in the Natural Ventilated Greenhouse. *Jurnal Tanah dan Iklim* *44*(1), 31–36.

Mustawa, M., Abdullah, S. H., Mahardhian, G., & Putra, D. (2017). Analisis Efisiendi Irigasi Tetes pada berbagai Tekstur Tanah untuk Tanaman Sawi (Brassica juncea). *Jurnal Ilmiah Rekayasa Pertanian Dan Biosistem*, *5*(2), 408–421. https://core.ac.uk/download/pdf/297915864.pdf

Nugroho, C. A., & Setiawan, A. W. (2022). Pengaruh Frekuensi Penyiraman Dan Volume Air Media Tanam Campuran Arang Sekam dan Pupuk Kandang. *Agrium*, *25*(1), 12–23.

Priyanto, Y. G. (2022). Potensi Lahan Kering dalam Peningkatan Produksi Padi Nasional. *Kementrian Pertanian Direktorat Jenderal Tanaman Pangan.*

Sajali, C. U., & Khoiriah, S. (2023). Analisis Kelayakan Usahatani Sayuran Sawi Pagoda (Brassica narinosa L.) Hidroponik di HPT Farm Tulungagung. *Agrisintech (Journal of Agribusiness and Agrotechnology)*, *4*(2), 58–63. https://doi.org/10.31938/agrisintech.v4i2.600

Saputra, M., Ridwan, Amien, R. E., & Amin, M. (2022). Pengaruh Kombinasi Media Tanam dan Debit Pacar Irigasi Tetes Terhadap Pertumbuhan dan Produksi Sawi (Brassica juncea L). *Jurnal Agricultura Biosystem Engineering*, *1*(1), 12–19. https://jurnal.fp.unila.ac.id/index.php/ABE/index

Sunik, S.T., M. ., Benedictus Sonny Yoedono, S.Pd., M. T., & Redemptus Narda Ratman Manao, S. . (2023). Memanfaatkan Setetes Air : Teknologi Irigasi Untuk Produktivitas Tanaman. *Yayasan DPI.*

Steven Witman. (2021). Penerapan Metode Irigasi Tetes Guna Mendukung Efisiensi Penggunaan Air di Lahan Kering. *Jurnal Triton*, *12*(1), 20–28. https://doi.org/10.47687/jt.v12i1.152

Yi, H., Chen, Y., & Anderson, C. T. (2022). Turgor pressure change in stomatal guard cells arises from interactions between water influx and mechanical responses of their cell walls. *Quantitative Plant Biology*: Cambridge University Press.

Za, T., Ahsan, M., Khan, M., Iqbal, A., Sherazi, S. (2026). Impact Of Water Stress On Cucumber Growth And Yield. *Journal of Life and Social Sciences*. 1–5.