Content lists available at PublikasiPolije
International Journal of Technology, Food and Agriculture (TEFA)
journal homepage : https://publikasi.polije.ac.id/index.php/tefa

Article

Tomato Growth and Production under Different Concentrations of Weed Extract-Based Biostimulant in Dry Season

Fadil Rohman [1*], Refa Firgiyanto [2], Gallyndra Fatkhu Dinata [3], Hanif Fatur Rohman [4], Edi Siswadi [5], M. Zayin Sukri [6], Anggita Rizqy Fadilah [7], and Haikal Firdausi [8]

[1] Department of Agricultural Production, Politeknik Negeri Jember; fadil.rohman@polije.ac.id
[2] Department of Agricultural Production, Politeknik Negeri Jember; refa_firgiyanto@polije.ac.id
[3] Department of Agricultural Production, Politeknik Negeri Jember; gallyndra.fatkhu@polije.ac.id
[4] Department of Agricultural Production, Politeknik Negeri Jember; haniffaturrohman@polije.ac.id
[5] Department of Agricultural Production, Politeknik Negeri Jember; edi_sis@polije.ac.id
[6] Department of Agricultural Production, Politeknik Negeri Jember; mzayinsukri@gmail.com
[7] Department of Agricultural Production, Politeknik Negeri Jember; anggita.rf@polije.ac.id
[8] Department of Agricultural Production, Politeknik Negeri Jember; haikalfirdausi99@gmail.com

* Correspondence: fadil.rohman@polije.ac.id

Abstract: Tomato farmers in Indonesia face challenges such as unpredictable weather conditions that can affect crop yields. Climatic stress, such as drought and heat, can have significant effects on plant growth. Plant Biostimulant have been shown to alleviate climatic stress in plants by modifying physiological processes and enhancing stress tolerance, ultimately improving crop growth and productivity. Recently, weed extract can serve as a biostimulant to improve growth and productivity of crops. This research aimed to determine the best concentration of weed extract-based biostimulant (WEBB) to increase tomato growth and production in dry season. The research was conducted on June to September 2024 in Tutul Village, Balung District, Jember Regency. The research used Randomized Block Design consisted of five levels of WEBB concentrations, i.e. 0, 1, 2, 3 and 4 ppm. The concentration of WEBB at 1 ppm significantly increased early growth of stem and the number of leaves at 2 WAP by 16.39% and 39.02% respectively. The application of WEBB at 1–2 ppm also showed a significant increase in the number of fruits by 24.49% compared to control. This indicated that 1 ppm WEBB were effective in stimulating the early growth and fruit formation on tomato plant.

Keywords: biosaka; drought stress, plant elicitor; plant height; the number of fruits; the number of leaves

Citation: F. Rohman, R. Firgiyanto, G. F. Dinata, H. F. Rohman, E. Siswadi, M. Z. Sukri, A. R. Fadilah, and H. Firdausi, "Tomato Growth and Production under Different Concentrations of Weed Extract-Based Biostimulant in Dry Season", *TEFA*, vol. 2, no. 2, pp. 107–114, Jun. 2025.

Received: 18-05-2025
Accepted: 25-06-2025
Published: 27-06-2025

1. Introduction

The prospects for tomato plants in Indonesia are promising due to the increasing market demand for tomatoes as a food commodity. Farmers in Indonesia are interested in tomato production as it is a short-lived and profitable vegetable [1]. However, tomato farmers in Indonesia face challenges such as limited access to quality seeds and fertilizers, as well as unpredictable weather conditions that can affect crop yields [2]. Climatic stress, such as drought and heat, can have significant effects on plant growth. These stresses can lead to adaptive changes in both roots and shoots, affecting water flux, root growth, and shoot functions. Stresses like drought and heat induce stomatal closure, decrease transpiration rate, and affect photosynthesis activity, ultimately impacting crop maturity and productivity. Among climatic constraints, drought and heat stress are particularly detrimental to tomato production. These stresses interfere with physiological processes, such as water flux, root development, and photosynthesis, leading to reduced plant growth, delayed crop maturity, and lower productivity [3]. In tomatoes, which are classified as C3 plants, drought stress can severely limit performance due to their relatively lower water-use efficiency compared to C4 plants. Therefore, strategies that improve drought resilience in tomato cultivation are essential, especially during the dry season.

One promising approach to mitigating the effects of abiotic stress is the application of plant biostimulants. Plant Biostimulant have been shown to alleviate climatic stress in plants by modifying physiological processes and enhancing stress tolerance, ultimately improving crop growth and productivity [4]. Several types of biostimulants that have been reported to increase plant growth under drought stress conditions are humic acid, microbial agents, and seaweed extract. The integrated use of humic acid and plant growth-promoting rhizobacteria has been found to significantly increase potato growth, tuber yield, and nutrient content under field conditions [5]. Additionally, humic acid can enhance chlorophyll content and photosynthetic activity, thereby promoting overall plant growth and yield [6] [7]. Seaweed extracts have also been reported to improve soil microbial activity and increase nitrogen availability, contributing to sustainable crop production [8]. Recently, weed extract can serve as a biostimulant in agriculture, providing a natural and eco-friendly alternative to inorganic fertilizers. Weed extracts have demonstrated positive effects on crop growth, nutrient uptake, and yield in several species, including tomato [8], chili [9][10], mustard, land kale [11] and sweet corn [12]. Furthermore, their use may reduce dependency on chemical fertilizers by increasing nutrient use efficiency.

The potential of weed extract as plant biostimulant was briefly reported on the growth and production on several plant commodities. However, its effect on the growth and production of tomato plants has not been clearly studied, especially in dry season. It was necessary to study the effect of weed extract-based biostimulant on tomato growth and production in dry season. This research aimed to determined the best concentration of weed extract-based biostimulant to increase tomato growth and production in dry season.

2. Materials and Methods

The research was conducted on June to September 2024 in Tutul Village, Balung District, Jember Regency, with coordinates 8°16′42″S 113°31′23″E. The weed extract-based biostimulant (WEBB) used in this research was Biosaka® that was obtained from market commercially. Cultivar of tomato plant used in this research was Servo/Gustavi that was able to grow well on the research site based on climatic characteristics.

The research used Randomized Block Design consisted of five levels of WEBB concentrations, i.e. 0, 1, 2, 3 and 4 ppm. Each treatment was repeated five times, so there were 25 experimental units. Each experimental units contained 12 plants, including six plants as observation samples. So, there were 300 plants in the total plant population. The research procedures included land preparation, seedlings preparation, planting, WEBB application, plant maintenance and harvesting (Figure 1).

Land preparation involved arranging experimental plots into 3 × 2 meter beds, with 50 cm spacing between beds. Seedlings were grown for three weeks in a nursery bed containing a mixture of manure and sand in a 1:1 ratio, using a seedbed size of 30 × 90 cm. After three weeks, seedlings were transplanted with a spacing of 70 × 60 cm between plants. WEBB was used directly according to the manufacturer's instructions without additional processing or dilution beyond the experimental concentrations. It was applied as a foliar spray using a knapsack sprayer, with a frequency of once per day during the third week after planting (WAP), targeting the plant canopy in the morning.

Plant maintenance involved routine agricultural practices, including manual weeding, replanting when needed, and watering twice daily (morning and evening). Each plant received NPK (16:16:16) fertilizer at a rate of 2 g/plant. Pest and disease control was carried out using commercial insecticides (JITE® and Movento® MPC) to manage aphids, whiteflies, and caterpillars. Harvesting was performed gradually from the 12th to the 16th WAP based on fruit ripeness.

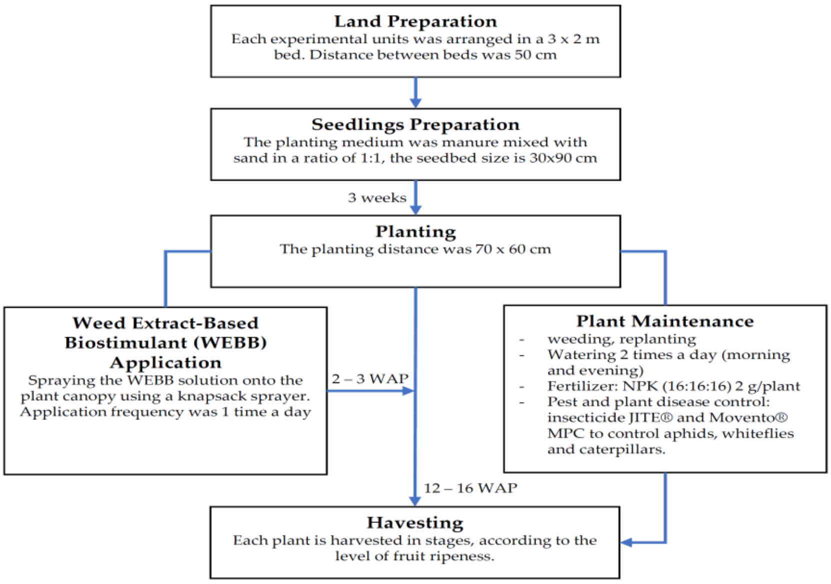

Figure 1. Research Procedures

The observation variables included plant height (cm), the number of leaves (blades), leaf area (cm^2), flowering set (DAP), fruit diameter (cm), single fruit weight (g), the number of fruit (fruits/plant) and total fruits weight (g/plant). Data were analyzed using analysis of variance (ANOVA) at 5% F test. The post-hoc test were analyzed according to Duncan's Multiple Range Test (DMRT) at α 5%.

3. Results and Discussion

3.1. Distribution of Rainfall At The Research Location

Rainfall data at the research site in Balung District, Jember Regency, from June to September 2024, showed a very low precipitation rate, with monthly totals of 14 mm in June, 1 mm in July, 1 mm in August, and 2 mm in September (Table 1). According to the Schmidt–Ferguson climate classification, a dry month is defined as a month with less than 60 mm of rainfall [13]. Based on this classification, all four months during the research period fall into the category of dry months, confirming that the experiment was conducted during the dry season.

Table 1. Precipitation on June – September 2024 in Balung District, Jember Regency

Month	Precipitation (mm)
June	14
July	1
August	1
September	2

Source: [14]

These dry conditions were highly relevant for the study, as they represent a climate scenario where water availability was limited and crop performance could be affected by drought stress. Therefore, evaluating the effectiveness of weed extract-based biostimulants under such conditions was critical for assessing their potential as adaptive inputs for dryland tomato production. The dry season in Indonesia can cause serious damage to crops due to a significant decrease in rainfall. Different regions in Indonesia experience varying types of rainfall, with some areas facing more severe droughts than others. The dry season (April-September) has larger rainfall variations compared to the wet season (October-March) [15]. Efforts to anticipate the impacts of climate change in agricultural sector include the development of adaptive technology innovations for dryland agriculture and water management to increase crop productivity. Climate change, including rising temperatures and changes in rainfall patterns, can impact crop production.

3.2. Plant Growth and Production Under Several Concentrations of WEBB

The application of WEBB at 1 ppm significantly increased plant height and number of leaves at 2 weeks after planting (WAP), as shown in Figures 1 and 2. Specifically, WEBB 1 ppm resulted in the tallest plants and highest number of leaves at this early stage. This indicated that in the early growth phase, tomato plants respond positively to the stimulation of bioactive compounds contained in weed extracts. These compounds likely acted as natural growth regulators that could stimulate cell division and elongation, thereby enhancing leaf development and early vegetative growth.

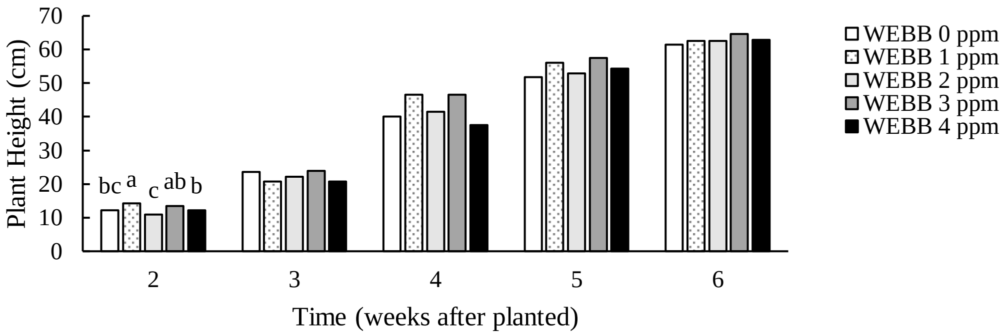

Figure 2. Plant height on several concentrations of WEBB

However, the positive effects did not last consistently in the following weeks (age 3–6 WAP), where there was no significant difference between WEBB concentration treatments on growth and number of leaves. This could be caused by several factors. First, the physiological adaptation ability of plants that began to stabilize with age, so that the response to external stimulation decreased. Second, it is possible that the active compounds in WEBB have been broken down or degraded before providing long-term effects, or the optimal dose was not enough to maintain its effect during the advanced growth phase.

These results were in line with the findings of several previous studies which stated that the effectiveness of natural biostimulants is greatly influenced by concentration, application time, and the developmental stage of the plant [16], [17]. At the early stages of growth, plants are very sensitive to the presence of stimulant compounds, but in the advanced vegetative and generative phases, environmental factors and the internal hormonal balance of the plants become more dominant in influencing growth. Thus, although WEBB 1 ppm showed potential in enhancing the early growth of tomato plants, further evaluation of the frequency and timing of application is needed to maintain its positive effects until the next growth phase.

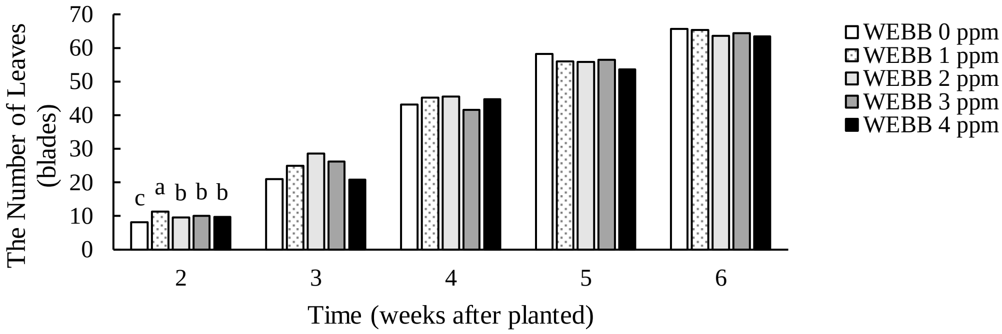

Figure 3. The number of leaves on several concentrations of WEBB

WEBB concentrations up to 4 ppm showed no significant effects on leaf area and flowering set (Figure 3). In terms of leaf area (Figure 3A), all treatments displayed relatively similar results, suggesting that the extract did not effectively stimulate leaf expansion. The leaf area in plants is greatly influenced by genetic factors as well as the balance of growth hormones such as auxins, cytokinins, and gibberellins [18], [19]. Possibly, the active compound content in WEBB did not reach the appropriate level or composition to significantly stimulate the process of leaf cell division and enlargement.

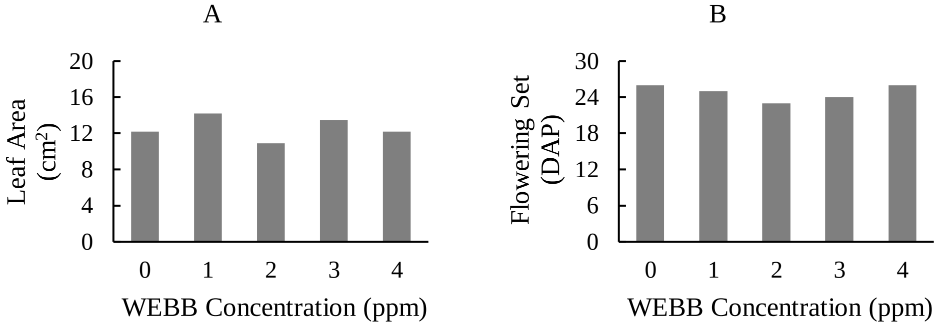

Figure 4. The effect of several WEBB concentrations on leaf area (A) and flowering set (B)

For flowering set (Figure 3B), the data showed that WEBB did not significantly accelerate or delay flowering. The process of flower initiation in tomato plants is the result of a complex interaction between internal factors (hormones and the physiological age of the plant) and external factors (light, temperature, and nutrient availability) [20]–[22]. Therefore, if the compounds in WEBB did not directly affect the hormonal balance related to the transition from the vegetative to the generative phase. Thus, while WEBB may enhance early vegetative growth, its role in transitioning to the generative phase appears limited. These results reinforced the point of view that not all types of natural biostimulants can provide comprehensive effects on all aspects of plant growth. Its effectiveness highly depends on the specific bioactive content, dosage, and synchronization of application with the plant growth phase [23], [24].

Applying 1-2 ppm WEBB significantly increased the number of fruits compared to other treatments (Figure 4C). These results indicated that low concentrations of biostimulants can trigger physiological responses in plants that contribute to increased fruit formation [25]. One possible mechanism that occurs was the increase in metabolic activity and nutrient absorption, which supports the process of early flower and fruit formation more optimally. The active compound content in WEBB, such as phenols, flavonoids, or natural growth hormones, was suspected to play a role in accelerating the flowering process and increasing the percentage of flowers turning into fruits.

However, no significant differences were observed in fruit diameter, single fruit weight, or total fruit weight (Figure 4A, B, D). This indicated that an increase in the number of fruits was not always accompanied by an improvement in fruit quality or size. This may be due to increased competition among a larger number of fruits for limited assimilates, resulting in reduced size or weight per fruit. Such trade-offs were reported in high-fruit-load conditions, where the plant's source strength could not meet the sink demand [26]. This phenomenon commonly occurs when plants produce a large number of fruits, but the reserves of energy and nutrients do not increase proportionally.

Moreover, the timing of WEBB application may not have aligned optimally with the fruit enlargement phase, and the concentration may have been insufficient to trigger further physiological responses needed for fruit development. These findings were in agreement with other studies proposed by [24] and [27] that the effectiveness of biostimulants highly depends on the concentration, application method, and compatibility with the physiological phase of the plant.

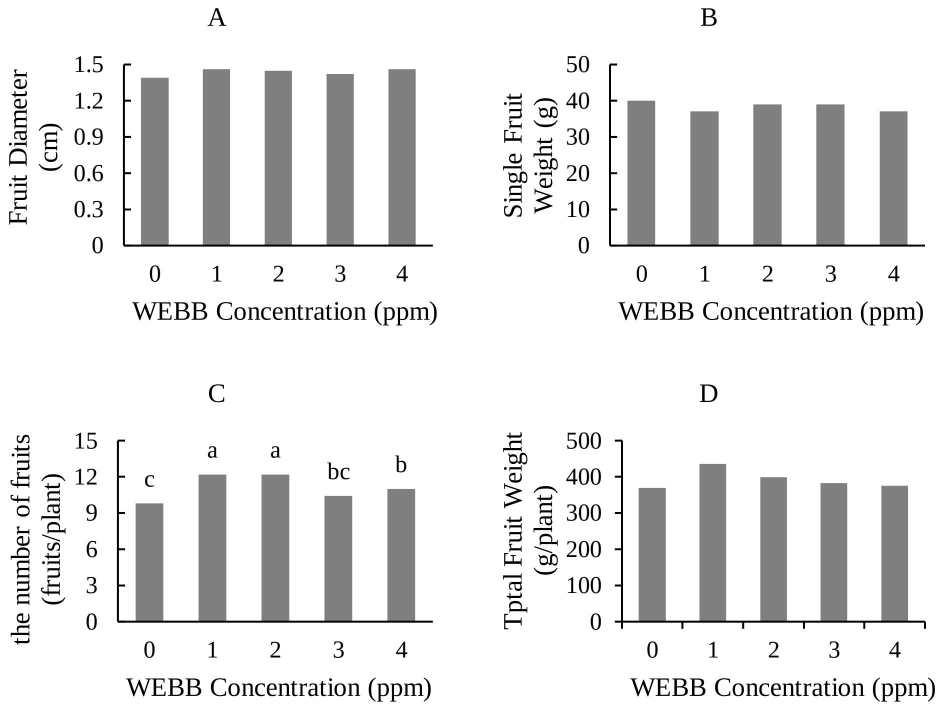

Figure 5. Plant production response under different concentration of WEBB. (A) fruit diameter; (B) single fruit weight; (C) the number of fruits and (D) total fruit weight

Thus, although a concentration of WEBB 1–2 ppm had been proven to increase the number of fruits, further strategies are needed to optimize the distribution of photosynthesis results in order to enhance the overall weight and size of the fruits. Further research that combines biostimulants with nutrient management or other cultivation techniques is important to support the overall improvement in crop quality.

4. Conclusions

The application of WEBB had varying effects on the growth and production of tomato plants during the dry season. The concentration of WEBB at 1 ppm significantly increased early growth of stem and the number of leaves at 2 WAP, but this effect did not continue into the subsequent growth phases (3–6 WAP). The application of WEBB at 1–2 ppm also showed a significant increase in the number of fruits, but it did not have a noticeable effect on fruit diameter, single fruit weight, or total fruit weight. This indicated that 1 ppm WEBB was effective in stimulating the early growth and fruit formation on tomato plant.

Therefore, the use of WEBB as a potential biostimulant needs to be optimized through the adjustment of concentration and application timing that is more precise according to the plant growth phase.

References

[1] W. Latif Mahmudi, A. Prasetyo, Suswadi, M. Ridyo Arum, and K. Prasetyowati, "Marketing Strategy Of Tomatoes (Solanum Lycopersicum Mill) Using Soar And Qspm Methods In The Argoayuningtani Farmers Group, Senden Village, Selo District Boyolali District," *J. Rural Urban Community Stud.*, vol. 2, no. 2, pp. 74–82, Aug. 2024, doi: 10.36728/jrucs.v2i2.4017.

[2] H. Safira, I. Iskandarini, and S. F. Ayu, "Analysis of tomato farmer income increasing strategies in Karo District, Indonesia," *Eur. J. Soc. Sci. Stud.*, vol. 8, no. 6, Jul. 2023, doi: 10.46827/ejsss.v8i6.1508.

[3] J. Lipiec, C. Doussan, A. Nosalewicz, and K. Kondracka, "Effect of drought and heat stresses on plant growth and yield: a review," *Int. Agrophysics*, vol. 27, no. 4, pp. 463–477, Dec. 2013, doi: 10.2478/intag-2013-0017.

[4] I. Bhupenchandra *et al.*, "Role of biostimulants in mitigating the effects of climate change on crop performance," *Front. Plant Sci.*, vol. 13, Oct. 2022, doi: 10.3389/fpls.2022.967665.

[5] Z. Ekin, "Integrated Use of Humic Acid and Plant Growth Promoting Rhizobacteria to Ensure Higher Potato Productivity in Sustainable Agriculture," *Sustainability*, vol. 11, no. 12, p. 3417, Jun. 2019, doi: 10.3390/su11123417.

[6] H. S. M. El-Bassiouny, B. A. Bakry, A. A. El-Monem Attia, and M. M. Abd Allah, "Physiological Role of Humic Acid and Nicotinamide on Improving Plant Growth, Yield, and Mineral Nutrient of Wheat," *Agric. Sci.*, vol. 05, no. 08, pp. 687–700, 2014, doi: 10.4236/as.2014.58072.

[7] F. Rohman, A. Wachjar, E. Santosa, and S. Abdoellah, "Humic Acid and Biofertilizer Applications Enhanced Pod and Cocoa Bean Production during the Dry Season at Kaliwining Plantation, Jember, East Java, Indonesia," *J. Trop. Crop Sci.*, vol. 6, no. 03, pp. 153–163, Oct. 2019, doi: 10.29244/jtcs.6.03.153-163.

[8] H. I. Hussain, N. Kasinadhuni, and T. Arioli, "The effect of seaweed extract on tomato plant growth, productivity and soil," *J. Appl. Phycol.*, vol. 33, no. 2, pp. 1305–1314, Apr. 2021, doi: 10.1007/s10811-021-02387-2.

[9] M. Pili, S. Wahid, and M. Husni, "Pengaruh pemberian biosaka dan vermikompos terhadap pertumbuhan dan hasil tanaman cabai rawit (Capsicum frutescens L)," vol. 16, no. 2, pp. 33–47, 2025.

[10] R. Elmiati, F. Ramona, and M. Habibillah, "Aplikasi biosaka sebagai subsitusi pupuk anorganik pada pertumbuhan dan hasil cabai (Capsicum annum l.) ramah lingkungan," *J. Sci. Res. Dev.*, vol. 6, no. 2, pp. 709–715, 2024.

[11] A. A. Prayitno, Sunawan, and N. Arfarita, "Pengaruh pemanfaatan biosaka dan pupuk npk terhadap pertumbuhan hasil tanaman kangkung darat (Ipomoea reptans Poir.)," *J. Agronisma*, vol. 1, no. 1, pp. 46–58, 2013.

[12] S. Umam, R. Padjung, and J. Muh, "Toward Greener Harvests: Unveiling the Synergistic Effects of Biochar and Biosaka on Sweet Corn (Zea mays saccharata) Growth, Yield, and Physiology," *BIO Web Conf.*, vol. 158, pp. 1–11, 2025, doi: 10.1051/bioconf/202515803010.

[13] F. H. Schmidt and J. H. A. Ferguson, *Rainfall Types Based on Wet and Dry Period Ratios for Indonesia with Western New Guinea*. Jakarta (ID): Ministry of Transport, Meteorology and Geophysics Service, 1951.

[14] Badan Pusat Statistik Kabupaten Jember, *Kabupaten Jember Dalam Angka 2025*, vol. 44. Jember (ID): BPS Kabupaten Jember, 2025.

[15] V. K. Boken, A. P. Cracknell, and R. L. Heathcote, *Monitoring and Predicting Agricultural Drought: A Global Study*, vol. 5, no. 4. New York (US): Oxford University Press, Inc., 2005. doi: 10.2136/vzj2006.0134br.

[16] R. Bulgari, G. Franzoni, and A. Ferrante, "Biostimulants application in horticultural crops under abiotic stress conditions," *Agronomy*, vol. 9, no. 6, p. 306, Jun. 2019, doi: 10.3390/agronomy9060306.

[17] M. Baltazar, S. Correia, K. J. Guinan, N. Sujeeth, R. Bragança, and B. Gonçalves, "Recent advances in the molecular effects of biostimulants in plants: an overview," *Biomolecules*, vol. 11, no. 8, p. 1096, Jul. 2021, doi: 10.3390/biom11081096.

[18] J. Sosnowski, M. Truba, and V. Vasileva, "The Impact of Auxin and Cytokinin on the Growth and Development of Selected Crops," *Agriculture*, vol. 13, no. 3, p. 724, Mar. 2023, doi: 10.3390/agriculture13030724.

[19] S. Ali and A. M. Baloch, "Overview of Sustainable Plant Growth and Differentiation and the Role of Hormones in Controlling Growth and Development of Plants Under Various Stresses," *Recent Pat. Food. Nutr. Agric.*, vol. 11, no. 2, pp. 105–114, Sep. 2020, doi: 10.2174/2212798410666190619104712.

[20] Z. Lee *et al.*, "Regulation of Flowering Time by Environmental Factors in Plants," *Plants*, vol. 12, no. 21, p. 3680, Oct. 2023, doi: 10.3390/plants12213680.

[21] H. Wang *et al.*, "Transcriptome Analysis of Flower Development and Mining of Genes Related to Flowering Time in Tomato (Solanum lycopersicum)," *Int. J. Mol. Sci.*, vol. 22, no. 15, p. 8128, Jul. 2021, doi: 10.3390/ijms22158128.

[22] R. Wang *et al.*, "Determining the Relationship between Floral Initiation and Source–Sink Dynamics of Tomato Seedlings Affected by Changes in Shading and Nutrients," *HortScience*, vol. 55, no. 4, pp. 457–464, Apr. 2020, doi: 10.21273/HORTSCI14753-19.

[23] P. du Jardin, "Plant biostimulants: Definition, concept, main categories and regulation," *Sci. Hortic. (Amsterdam).*, pp. 1–12,

2015, doi: 10.1016/j.scienta.2015.09.021.

[24] O. I. Yakhin, A. A. Lubyanov, I. A. Yakhin, and P. H. Brown, "Biostimulants in Plant Science: A Global Perspective," *Front. Plant Sci.*, vol. 7, pp. 1–32, Jan. 2017, doi: 10.3389/fpls.2016.02049.

[25] C. Andreotti, Y. Rouphael, G. Colla, and B. Basile, "Rate and Timing of Application of Biostimulant Substances to Enhance Fruit Tree Tolerance toward Environmental Stresses and Fruit Quality," *Agronomy*, vol. 12, no. 3, p. 603, Feb. 2022, doi: 10.3390/agronomy12030603.

[26] Anuradha, R. Goyal, and C. Bishnoi, "Assimilate partitioning and distribution in fruit crops: A review," *J. Pharmacogn. Phytochem.*, vol. 6, no. 3, pp. 479–484, 2017.

[27] P. Calvo, L. Nelson, and J. W. Kloepper, "Agricultural uses of plant biostimulants," *Plant Soil*, vol. 383, no. 1–2, pp. 3–41, Oct. 2014, doi: 10.1007/s11104-014-2131-8.