Jurnal Pijar MIPA
https://jurnalfkip.unram.ac.id/index.php/JPM

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

The Effect of Natural Plant Growth Regulator Concentration of Indian Red Onions on the Growth of Euphorbia *(Euphorbia geroldii)* Flowers

Dzikra Nasyaya Mahfudhah, Mirwa Adiprahara Anggarani*

Chemistry Department, Universitas Negeri Surabaya, Surabaya, Indonesia
*E-mail: mirwaanggarani@unesa.ac.id

Received: December 22, 2023. Accepted: January 11, 2024. Published: March 27, 2024

Abstract: The euphorbia flower (*euphorbia geroldii*), widely used by the public as an ornamental plant because of its visual beauty, has an aesthetic function and health benefits that still need to be researched. The euphorbia genus has antimicrobial, antioxidant, and antidiabetic activity, which comes from its abundant terpenoid compounds, flavonoids, and other phytochemical compounds. Due to these high benefits, optimization of cultivation is carried out by adding phytohormones, better known as Growth Regulatory Regulator (PGR), further to increase the quality and quantity of euphorbia flowers so that the economic value will also increase in the realm of the agricultural industry. This research aims to analyze the effect of the natural PGR concentration of red onions (*Allium cepa* L.) on the growth of euphorbia flowers, including the parameters of the number of flowers on one tree, the time the buds appear, and the duration of flower survival. The research method used was quantitative experimental using a one-factor Randomized Block Design (RBD), namely testing the effect of several variations in PGR concentration (0%, 1%, 3%, 5%, 7%, and 10%) and statistically analyzed using SPSS. The results of the research show that all variations in PGR concentration have a positive effect on all parameters, where the PGR concentration of 10% indicates the highest increase, including the average number of flowers on one tree, which is 13 flowers, the average time for buds to appear is 2.5 times in one week. The average duration of flower survival is 139.5 hours. It can be concluded that the natural PGR of red onions has a positive effect on all parameters, with the highest results shown at a concentration variation of 10%.

Keywords: Euphorbia; Flower Growth; , Indian Red Onion; Natural PGR.

Introduction

In general, euphorbia is widely used as an ornamental plant, indoors and outdoors, because the euphorbia flower (*Euphorbia geroldii*) is a succulent plant popular with the public because of its visual beauty. Euphorbia species also have unique flower structures: the special organ cyathium, where pollen develops, and the ovary for fertilization [1]. In fact, not only does it have a primary aesthetic function, euphorbia flowers are also rich in health benefits. One hundred fifty-one species from 44 Euphorbiaceae families have potential as traditional medicines [2]. All parts of the euphorbia plant were found to have antimicrobial, antioxidant, antitumor, molluscicidal, and antinociceptive activities, as well as an abundance of terpenoids, tannins, and flavonoids contained in the crude extract of the plant [3]. In Africa, euphorbia species treat skin diseases, migraines, gonorrhea, fungal disorders, inflammation, and sexual transmission. Based on these high benefits, more optimal cultivation is needed to increase the quality and quantity of euphorbia flowers so that the economic value will also increase in agricultural cultivation. Likewise, it is hoped that its usefulness will be more widespread, as the public knows that euphorbia flowers are used not only as ornamental plants but also for health.

One of the steps to optimize the cultivation of euphorbia flowers is by adding a Plant Growth Regulator (PGR), which has the primary function of stimulating and accelerating the growth rate and maximizing the flowering phase, which is generally still rarely done, even though flowers are the reproductive organs of plants which play a significant role in attracting pollinating insects. [5]. PGR can be obtained naturally or synthetically. However, natural PGR is currently preferred because it is affordable and environmentally friendly. Several natural PGRs are bamboo shoots, coconut water, banana tubers, green bean sprouts, and onion species, including shallots, garlic, and onions. Previous research regarding the effectiveness of onion extract as a natural PGR includes that on green mustard plants, shallot extract with a concentration of 50% worked optimally in increasing the average plant height by 20.33 cm [8]. Another study explains that onions can initiate flowering through stimulation by the phytohormone gibberellin, where the larger the size of the seed bulb used, it is proven to have a higher concentration of natural gibberellin content, resulting in higher flowering and fruit and seed yields [9].

Another onion species that also has the potential to be a natural PGR is the red onion, where previous research has rarely used this type of onion for plant growth. Apart from being in the same species as onions and therefore containing similar compounds, red onions themselves are rich in bioactive compounds such as alkaloids and terpenoids [10] with various derivative compounds, including the phytohormone auxin [11] and the gibberellin hormone which plays a vital role in the flowering period by stimulating the rate of bud emergence before the flowers

How to Cite:
Mahfudhah, D. N., & Anggarani, M. A. (2024). The Effect of Natural Plant Growth Regulator Concentration of Indian Red Onions on the Growth of Euphorbia (Euphorbia geroldii) Flowers . *Jurnal Pijar Mipa*, *19*(2), 302–307. https://doi.org/10.29303/jpm.v19i2.6363

finally open, as well as speeding up flowering time [12]. In addition, plant growth parameters that have been carried out in previous studies rarely focus on the flowering phase but instead on other plant parts, such as parameters related to roots, stems, and leaves. The phytohormone content in red onions plays an essential role in regulating every aspect of growth and development, including the induction of flowering [13]. Thus, using red onions as a natural PGR can be a breakthrough for the world of research and development in the agricultural industry related to using environmentally friendly PGR and affordable prices.

This research aims to determine the effect of each variation in concentration of red onion extract on the growth of euphorbia flowers, including the number of flowers on one tree, the time the buds appear, and the duration of flower survival.

Research Methods

This research was carried out from May 2023 to September 2023 in Burneh District, Bangkalan Regency, Madura, using a quantitative approach with a Randomized Block Design (RBD) method with one factor, namely the concentration of natural PGR, which consists of 6 levels, and each treatment consists of 4 replications. The materials used in this study include red onions, euphorbia flower seeds, planting media in the form of a mixture of rice husks and soil, and water. The tools needed are an oven, rotary evaporator, blender, and polybag.

The Indian red onion simplicia will first be extracted by maceration using ethanol solvent (96%) for 3 x 24 hours, then filtered to obtain filtrate and residue. The crude extract (filtrate) is evaporated to remove the solvent. Several quality parameters, including water content, viscosity, and pH tests, determine the quality of the extract. The variations in PGR concentration used in this research were 0% (control), 1%, 3%, 5%, 7%, and 10%, which were applied to euphorbia flower plants every week, complete with watering, which is done for each a day.

Observations of growth parameters started when the plants had sturdy stems and true leaves (2 months), including the number of flowers in one tree, which was calculated by adding up the total flowers of each plant that had produced buds until they bloomed. The time parameters for bud emergence were calculated from when they were formed. Buds in HST units and the duration parameter of flower survival from when the flower blooms to wilting are measured by calculating the total time from blooming to fall in days after blooming (HSM) [15]. The observation data was then analyzed statistically using the One Way ANOVA test and Duncan's advanced test in the SPSS application to see the effect of variations in PGR concentration on the parameters that had been determined.

Results and Discussion

Number of Flowers on One Tree

The effect of giving natural PGR on red onions on the number of flowers in one euphorbia tree during 12 weeks of observation can be seen in Table 1.

Table 1. The average number of flowers on a Euphorbia tree from 8th to 12th weeks

Concentration	The average number of flowers on a Euphorbia tree				
	8 MST	9 MST	10 MST	11 MST	12 MST
0%	0.50±1.0[a]	1.75±1.70[a]	3.25±3.59[a]	3.25±1.63[a]	6.75±2.5[a]
1%	1.25±1.25[a]	2.75±0.95	5.50±2.51	6.50±7.59	8.50±4.43
3%	1.25±0.5[a]	4.25±2.62	4.75±4.9	11.75±6.65	12.0±13.8
5%	2.50±1.91[ab]	3.31±2.24	3.68±4.7	7.18±6.74	8.56±6.8
7%	3.75±0.5[b]	6.50±1.91	3.25±3.77	3.50±5.0	6.75±5.85
10%	4.25±1.7[b]	5.0±2.44	3.75±4.34	7.50±6.55	13.0±15.2

Note: If numbers followed by letters are not the same in the same column, they are considered significantly different according to the Duncan test at a 5% significance level.

Table 1 shows that all variations in the natural PGR concentration of red onions positively affect the parameters of the number of flowers in one euphorbia tree. Apart from that, the highest number of flowers was produced by the 10% PGR treatment variation, namely 13, compared to the treatment variations below, especially the control, which is 6.75. Figure 1 below compares the number of flowers in the euphorbia tree in each concentration.

Bud Emergence Time

The effect of giving natural PGR on red onions on the number of flowers in one euphorbia tree during 12 weeks of observation can be seen in Table 2.

Table 2 shows that all variations in the natural PGR concentration of red onions positively affect the time parameters for euphorbia flower bud emergence. The highest frequency of bud emergence was produced by the 10% PGR treatment variation, 2.5 times a week, compared to variations in concentrations below, especially the control one time a week.

Duration of Flower Survival

The effect of giving natural PGR on red onions on the duration of euphorbia flower survival during 12 weeks of observation can be seen in Table 3.

Table 3 shows that all variations in the natural PGR concentration of red onions positively affect the duration parameters of euphorbia flower survival. Apart from that, the highest duration of flower resistance was produced by the 10% PGR treatment variation, namely 139.5 hours (5.8 days), compared to variations in concentrations below, especially the control, which survived for 90 hours (3.75 days).

Figure 1. Comparison of the number of flowers in an Ephorbia tree at each concentration: (from left to right) 0%; 1%; 3%; 5%; 7%; 10%. 10% PGR concentration reached the highest number of flowers compared to the lower concentrations.

Table 2. The average time for the emergence of Euphorbia flower buds from 8th to 12th weeks

Concentration	The average time for the emergence of Euphorbia flower buds				
	8 MST	9 MST	10 MST	11 MST	12 MST
0%	0.25±0.5[a]	0.66±0.57[a]	0.50±0.7[ab]	0.75±0.95[a]	1.0±0.57[a]
1%	0.75±0.5[a]	1.0±0.0[a]	1.25±0.95[ab]	1.25±0.5[ab]	1.25±0.95
3%	1.0±0.0[ab]	1.25±0.5[ab]	1.25±0.95[ab]	2.5±0.57[c]	1.25±0.5
5%	0.75±0.5[a]	1.25±0.5[ab]	0.75±0.5[ab]	1.0±0.81[a]	1.25±0.95
7%	1.0±0.81[ab]	1.0±0.0[a]	0.25±0.5[a]	0.50±1.0[a]	1.5±1.0
10%	1.75±0.5[b]	2.0±0.81[b]	2.0±1.41[b]	2.25±0.5[bc]	2.5±1.0

Note: If numbers followed by letters are not the same in the same column, they are considered significantly different according to the Duncan test at a 5% significance level.

Table 3. The average duration of Euphorbia flower survival from 8th to 12th weeks

Concentration	The average duration of Euphorbia flower survival				
	8 MST	9 MST	10 MST	11 MST	12 MST
0%	73.0±7.5[a]	73.50±3.0[a]	81.0±3.46[a]	83.0±43.1[a]	90.0±12.0[a]
1%	79.50±5.7[ab]	85.50±7.54[b]	92.50±3.0[b]	94.0±4.8	94.50±53.07
3%	87.0±11.4[bc]	91.50±13.3[b]	93.50±5.74[b]	85.50±57.6	94.50±63.2
5%	94.50±7.5[cd]	109.50±7.54[c]	99.0±3.46[b]	88.50±59.4	90.0±60.7
7%	100.50±5.74[d]	120.0±0.0[cd]	123.0±3.46[c]	124.0±63.2	129.0±83.7
10%	123.0±3.46[e]	124.50±6.0[d]	129.0±9.7[c]	136.50±85.04	139.5±88

Note: If numbers followed by letters are not the same in the same column, they are considered significantly different according to the Duncan test at a 5% significance level.

Based on statistical analysis regarding the effect of the application of natural PGR on Indian red onions on flower growth parameters, namely the number of flowers on one tree, the time the buds appear, and the duration of flower survival of the euphorbia which has been described previously, the results show that natural PGR on Indian red onions has a positive effect on all flower growth parameters. Indian red onion contains phytohormones auxin and gibberellin, which stimulate plant growth, especially the flowering phase. The phytohormone content of auxin and gibberellin in Indian red onions is not only based on the similarity of the species with red onions so that the content is not much different; these two growth hormones are generally found in all plants that have a vascular system (transport tissue) In addition, Indian red onions contain alkaloids and terpenoids, where the phytohormones auxin and gibberellin are derivatives of these two compounds.

However, there was a decrease in certain observation weeks caused by many factors, including the observation duration limit calculated every week and environmental conditions with minimal sunlight. Hence, the photosynthesis process is not optimal. Automatically, the nutrients and food produced go the same [16]. Apart from that, the wind speed made due to environmental conditions, which tend to be windy and cloudy, means that flowers that are blooming or about to bloom with a soft and fragile structure have the potential to be carried away by the wind. Fungi, bacteria, or pests found on plants are also not anticipated early, thus causing disease in plants [17]. Tarkus Suganda, Professor at the Faculty of Agriculture, Padjadjaran University, said that ornamental plants are very susceptible to disease (fungi or bacteria), especially if it has entered the rainy season. The fungus or bacteria that causes this disease is easily transmitted with uniform types and plants that are close together, as well as the influence of human intervention, which contributes to the spread of the disease [18]. Based on this, using natural PGR must also be accompanied by pest control through insecticides or similar to maximize growth.

The phytohormone content in PGR works in several ways. The mechanism of the gibberellin hormone in inducing flowering includes binding to the GID1 receptor,

which then binds to the SCF E3 ligase complex and also the GID1 inhibitor, namely the DELLA protein, followed by the transfer of polyubiquitin, which binds to the DELLA protein inhibitor. The 26S proteasome then degrades DELLA. At the same time, GID1, which has been released from the inhibitor, will be active [19] and begin to activate the expression of specific genes related to flowering, including the flowering locus T (FT) gene and the SPL gene (Squamosa Promoter Binding Protein-Like) which will produce florigen proteins, FT (flowering locus T) and FD (Flowering locus D) to induce flowers and regulate the time of flower appearance. After the florigen protein is produced, it will be sent to all growth centers to make flowers. The FT and FD proteins trigger the formation of flower buds and flowering [24], including starting the initiation of flowering, which automatically impacts the appearance of flowers, controlling flowering time and the number of flowers in plants [25]. The SPL gene also contributes to developing the sexual organs (stamen and pistil), petals, and stamens.

In addition, the hormone gibberellin also plays a role in inducing flowering related to the identity of plant photoperiodism. If gibberellin hormone levels are not optimal, flowering time will be delayed in long-day plants, while in short-day plants, it can prevent flowering. Exogenous administration of the hormone gibberellin (GA) has been proven to accelerate the flowering process, especially when plants are planted in conditions where it is challenging to bloom because they are in an environment that does not match the photoperiodic identity of the plant.

The hormone auxin also plays a role that is no less important. Auxin acts through the interaction of auxin with the ARF8 and ARF6 proteins, functions in suppressing the expression of a Class 1 KNOX (Class 1 Knotted-Like Homeobox) gene [28], where the class 1 KNOX gene functions to keep plant cells growing and developing. The presence of ARF6 and ARF8 can suppress the expression of this gene if it is felt to be excessive so that flower growth remains normal, both in terms of structure and shape. Exaggerated gene expression can cause flowers to become deformed and disrupt their normal reproductive function, which also impacts flower survival, which is not optimal [29].

Another mechanism is binding to the E3 ligase protein, almost the same as the gibberellin hormone. Auxin has a response compound called ARF (Auxin Response Factor) in plants, where when the plant is not receiving auxin, ARF will be inhibited by a specific inhibitor called Aux/IAA. However, when auxin is in the plant, a particular receptor (TIR1/AFB) will bind to the auxin, which is included in the E3 protein ligase complex. Once the receptor is active, it will transfer polyubiquitin to attach to the auxin inhibitor (Aux/IAA) so the ARF inhibitor can be released and degraded by the *26S proteasome* [30,31,32]. With the degradation of the ARF inhibitor, ARF will be active and transported into the nucleus to activate transcription by the SAUR (Small Auxin Up-regulated RNAs) genes [33] and GH3 (*Gretchen Hagen3*). After the transcription process is complete, the mRNA will be taken to the ribosomes to translate and produce amino acids, which play a role in the flowering process.

Research regarding the effectiveness of red onion extract as a natural PGR on growth is scarce and has never been done before. In 2022, a preliminary study was conducted regarding phytochemical screening, total phenolics, flavonoids, and antioxidant activity in red onion extracts [16]. Meanwhile, further research, in this case regarding its application as a natural PGR, is generally widely used in other onion species, specifically shallots, including in fig fruit plants (*Ficus carica*), giving shallot PGR at a concentration of 1.14% is optimal in increasing root length. A concentration of 1.07% is optimal in increasing the number of roots [36]. In mini soka plants (*Ixora coccinea*), Shallot PGR with concentrations of 80% and 90% was able to speed up the emergence of shoots and growth in root length and produce a significant number of shoots. The number of primary roots and shoot length also experienced the highest increase at the same concentration. The results of a study conducted by [38] in Manokwari, shallot PGR concentrations of 75% and 100% showed the highest germination percentage in cocoa seed plants, namely 100%, which when compared with the control (0%), the germination percentage is only 85%. The height of the cocoa seed plants also showed maximum results at a concentration of 100%, namely 19.55 cm. In shoot cuttings of chrysanthemum plants (*Chrysanthemum* sp), the application of shallot PGR concentration of 80% showed maximum results for the number of roots, namely 19, and root length, namely 3.7 cm [39].

The application of PGR, which focuses on flower growth, is generally widely used synthetic PGR, including research conducted by [14] showing that giving the gibberellin hormone at a concentration of 800 ppm is optimal in increasing the number of marigold (*Cosmos* sp.) flowers by 156.80 florets, flower diameter of 3.38 cm and average flowering time of 41.2 HST. In another study by [40], giving the gibberellin (GA3) at a concentration of 400 ppm significantly increased the length of the flower stalk and the freshness of chrysanthemum flowers (*Chrysanthemum morifolium* Ramat) in the 12th weeks of planting. Pink soka plants [41] in their research explained that the application of gibberellin with a concentration of 150 ppm can increase the flower appearance time (at 29 HST) and the number of flowers on pink soka plants (*Ixora coccinea* L.) as much as 14.33.

Conclusion

Based on the research that has been carried out, it can be concluded that the application of various concentrations of natural PGR on red onions has a positive effect on all parameters of euphorbia flower growth, with the 10% PGR treatment variation showing the highest value for all parameters, including the average value of the number of flowers on one tree of 13 the time for flower buds to appear is 2.5 times a week. The duration of flower survival is 139.5 hours (5.8 days). Apart from that, controlling pests or plant diseases must still be done by using insecticides and the like to further maximize the work of PGR.

References

[1] Gunawan, F. I., Mulyana, F. W., Supriyatna, A., & Biologi, P. S. (2023). Inventarisasi Dan Analisis Jenis Tumbuhan Famili Euphorbiaceae Dan Sebarannya Di

Desa Cipeundeuy, Kecamatan Bantarujeg, Kabupaten. *Jurnal Riset Rumpun Ilmu Tanaman*, *2*(1).

[2] Adhil, Iqbal, M., & Ramadani. (2019). Kajian Etnobotani Suku Euphorbiaceae yang Dimanfaatkan oleh Suku Pekurehua di Desa Wuasa dan Kaduwaa Kecamatan Lore Utara Kabupaten Poso Sulawesi Tengah. *Natural Science: Journal of Science and Technology ISSN*, *8*(1), 51–60.

[3] Divya, Kt., Dipen, Ks., Kirtan, Ps., Ashish, Ps., & Avinash, Ks. (2016). Extract of Euphorbia milii flower: A natural indicator in acid-base titration. *Journal of Integrated Health Sciences*, *4*(2), 2.

[4] Toudert, N., Zakkad, F., Dadda, N., Djilani, A., Dicko, A., & Djilani, S. E. (2021). Phytochemical analysis of bioactive extracts and seed oil of three euphorbia species from Algerian flora by lc-ms and gc-ms. *Indonesian Journal of Chemistry*, *21*(3), 546–553.

[5] Tanjung, T. Y., & Darmansyah. (2021). Pengaruh Penggunaan ZPT Alami dan Buatan terhadap Pertumbuhan Setek Tanaman Delima (Punica granatum L.). *Jurnal Hortuscoler*, *2*(1), 6–13.

[6] Abror, M., & Noviyanti, D. D. (2019). Pengaruh Beberapa Jenis ZPT terhadap Pertumbuhan Stek Batang Murbei (Morus alba L.). *Jurnal Nabatia*, *7*(1), 19–28. https://doi.org/10.21070/nabatia.v7i1.452

[7] Ramadhani, S. (2021). Uji Beberapa Jenis dan Konsentrasi ZPT Alami terhadap Pertumbuhan Setek Nilam (Pogostemon cablin Benth). In *Universitas Islam Riau*. Universitas Islam Riau.

[8] Nababan, R. S., Gustianty, L. R., Efendi, E., Kailan, S., Nova, V., Caisim, S. S., & Tosakan, V. (2017). Pengaruh Aplikasi ZPT Organik terhadap Pertumbuhan dan Produksi Berbagai Varietas Sawi Hijau (Pai-Tsai) (Brassica juncea L .). *Agricultural Research Journal*, *14*(2), 124–133.

[9] Sumiati, E., & Sumarni, N. (2006). Pengaruh Kultivar dan Ukuran Umbi Bibit Bawang Bombay Introduksi terhadap Pertumbuhan, Pembungaan, dan Produksi Benih. *Jurnal Hortikultura*, *16*(1), 12–20.

[10] Hidayah, L. A., & Anggarani, M. A. (2022). Determination of Total Phenolic, Total Flavonoid, and Antioxidant Activity of India Onion Extract. *Indonesian Journal of Chemical Science*, *11*(2).

[11] Prameswari, S., & Pratomo, B. (2021). Pengaruh Ekstrak Bawang Merah dan Zat Pengatur Tumbuh Auksin terhadap Pertumbuhan Setek Mucuna bracteata D.C. *Agrinula*, *4*(2), 130–138.

[12] Ogunyale, O. G., Fawibe, O. O., Ajiboye, A. A., & Agboola, D. A. (2014). A Review of Plant Growth Substances: Their Forms, Structures, Synthesis and Functions. *J. Adv. Lab. Res. Biol.*, *5*(4), 152–168.

[13] Goldberg-Moeller, R., Shalom, L., Shlizerman, L., Samuels, S., Zur, N., Ophir, R., Blumwald, E., & Sadka, A. (2013). Effects of gibberellin treatment during flowering induction period on global gene expression and the transcription of flowering-control genes in Citrus buds. *Plant Science*, *198*, 46–57.

[14] Dalili Sharfina, F., & Yuliani. (2023). Pemberian berbagai Konsentrasi Hormon Giberelin terhadap Pertumbuhan dan Pembungaan Tanaman Kenikir (Cosmos sp.). *Jurnal LenteraBio*, *12*(3), 396–404.

[15] Suputra, I. M. W., Wijaya, I. M. A. S., & Tika, I. W. (2015). Kajian Frekuensi dan Lama Pemaparan Medan Elektromagnetik pada Fase Generatif terhadap Produksi dan Kualitas Bunga Krisan (Crhysantemum). *Jurnal BETA (Biosistem Dan Teknik Pertanian)*, *3*(2), 1–12.

[16] Wang, Y., Burgess, S. J., de Becker, E. M., & Long, S. P. (2020). Photosynthesis in the fleeting shadows: an overlooked opportunity for increasing crop productivity? *Plant Journal*, *101*(4), 874–884.

[17] Guest, D. I. (2016). Plant Pathology, Principles. In *Encyclopedia of Applied Plant Sciences* (Second Edi, Vol. 3). Elsevier.

[18] Maulana, A. (2020). *Hobi Koleksi Tanaman Hias, Waspadai Hama dan Penyakitnya*.

[19] Hernández-García, J., Briones-Moreno, A., & Blázquez, M. A. (2021). Origin and evolution of gibberellin signaling and metabolism in plants. *Seminars in Cell and Developmental Biology*, *109*(March), 46–54.

[20] Jeyakumar, J. M. J., Ali, A., Wang, W. M., & Thiruvengadam, M. (2020). Characterizing the role of the miR156-SPL network in plant development and stress response. *Plants*, *9*(9), 1–15.

[21] Zhang, S., Gottschalk, C., & Van Nocker, S. (2019). Genetic mechanisms in the repression of flowering by gibberellins in apple (Malus x domestica Borkh.). *BMC Genomics*, *20*(747), 1–15.

[22] Shalit-Kaneh, A., Eviatar-Ribak, T., Horev, G., Suss, N., Aloni, R., Eshed, Y., & Lifschitz, E. (2019). The flowering hormone florigen accelerates secondary cell wall biogenesis to harmonize vascular maturation with reproductive development. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(32), 16127–16136.

[23] Tsuji, H. (2017). Molecular function of florigen. *Breeding Science*, *67*(4), 327–332.

[24] Poethig, R. S. (2014). Vegetative phase change and shoot maturation in plants. *Curr Top Dev Biol.*, *105*(6), 125–152.

[25] Gao, L., Lyu, T., & Lyu, Y. (2022). Genome-Wide Analysis of the SPL Gene Family and Expression Analysis during Flowering Induction in Prunus × yedoensis' Somei-yoshino.' *International Journal of Molecular Sciences*, *23*(17).

[26] Andrés, F., Romera-Branchat, M., Martínez-Gallegos, R., Patel, V., Schneeberger, K., Jang, S., Altmüller, J., Nürnberg, P., & Coupland, G. (2015). Floral induction in Arabidopsis by flowering locus t requires direct repression of blade-on-petiole genes by the homeodomain protein pennywise. *Plant Physiology*, *169*(3), 2187–2199.

[27] Bauerle, W. L. (2022). Gibberellin A3 induced flowering intensification in Humulus lupulus L. : Synchronizing vegetative phase change and photoperiod induction. *Elsevier*, 1–22.

[28] Yang, Q., Cong, T., Yao, Y., Cheng, T., Yuan, C., & Zhang, Q. (2023). KNOX Genes Were Involved in Regulating Axillary Bud Formation of Chrysanthemum × morifolium. *International Journal of Molecular Sciences*, *24*(8), 1–18.

[29] Zhang, R., Min, Y., Holappa, L. D., Walcher-Chevillet, C. L., Duan, X., Donaldson, E., Kong, H., & Kramer, E. M. (2020). A role for the Auxin Response Factors ARF6 and ARF8 homologs in petal

spur elongation and nectary maturation in Aquilegia. *New Phytologist*, *227*(5), 1392–1405.

[30] Chung, Y., Zhu, Y., Wu, M. F., Simonini, S., Kuhn, A., Armenta-Medina, A., Jin, R., Østergaard, L., Gillmor, C. S., & Wagner, D. (2019). Auxin Response Factors promote organogenesis by chromatin-mediated repression of the pluripotency gene SHOOTMERISTEMLESS. *Nature Communications*, *10*(1).

[31] Lavy, M., & Estelle, M. (2016). Mechanisms of auxin signaling. *Development (Cambridge)*, *143*(18), 3226–3229.

[32] Leyser, O. (2018). Auxin signaling. *Plant Physiology*, *176*(1), 465–479. https://doi.org/10.1104/pp.17.00765

[33] Stortenbeker, N., & Bemer, M. (2019). The SAUR gene family: The plant's toolbox for adaptation of growth and development. *Journal of Experimental Botany*, *70*(1), 17–27.

[34] Gan, Z., Fei, L., Shan, N., Fu, Y., & Chen, J. (2019). Identification and expression analysis of gretchen hagen 3 (Gh3) in kiwifruit (actinidia chinensis) during postharvest process. *Plants*, *8*(11), 1–13.

[35] Gomes, G. L. B., & Scortecci, K. C. (2021). Auxin and its role in plant development: structure, signalling, regulation and response mechanisms. *Plant Biology*, *23*(6), 894–904.

[36] Sofwan, N., Faelasofa, O., Triatmoko, A. H., & Iftitah, S. N. (2018). Optimalisasi ZPT (Zat Pengatur Tumbuh) Alami Ekstrak Bawang Merah (Allium cepa Fa. Ascalonicum) sebagai Pemacu Pertumbuhan Akar Stek Tanaman Buah Tin (Ficus carica). *Jurnal Ilmu Pertanian Tropika Dan Subtropika*, *3*(2), 46–48.

[37] Salsabila, R., Karno, & Purbajanti, E. (2021). Respon Pertumbuhan Stek Soka Mini (Ixora coccinea) Terhadap Konsentrasi Pemberian Dan Lama Perendaman ZPT Alami Ekstrak Bawang Merah. *J. Agro Complex*, *5*(1), 57–65.

[38] Paelongan, A. H., Malau, K. M., & Semahu, L. H. (2023). Pengaruh Ekstrak Bawang Merah (Allium cepa L.) sebagai Zat Pengatur Tumbuh pada Benih Kakao (Theobroma cacao L.). *Jurnal Agro Industri Perkebunan*, *11*(3), 185–196.

[39] Fadhil, I., Rahayu, T., & Hayati, A. (2018). Pengaruh Kulit Bawang Merah (Allium cepa L.) Sebagai Zpt Alami Terhadap Pembentukan Akar Stek Pucuk Tanaman Krisan (Chrysanthemum sp). *Jurnal SAINS ALAMI (Known Nature)*, *1*(1), 34–38.

[40] Sembiring, E. K. D. B. S., Sulistyaningsih, E., & Shintiavira, H. (2021). Pengaruh Berbagai Konsentrasi Giberelin (GA 3) terhadap Pertumbuhan dan Kualitas Hasil Bunga Krisan (Chrysanthemum morifolium Ramat.) di Dataran Medium. *Vegetalika*, *10*(1), 44–55.

[41] Hidayati, A. R., Nurlaelih, E. E., & Heddy, S. (2019). Pengaruh Pemberian Hormon Giberelin (GA3) terhadap Pembungaan Tiga Jenis Tanaman Soka (Ixora coccinea L.). *Jurnal Produksi Tanaman*, *7*(2), 240–247.