ASEAN
Journal of Scientific and Technological Reports
Online ISSN:2773-8752

Research article

Optimizing Organic Fertilization for Marguerite Daisy (*Argyranthemum frutescens*): Impact of Application Rate and Frequency on Growth and Yield

Chamaiporn Anuwong[1], Phissanu Kaewtaphan[2], and Pattrarat Teamkao[3*]

[1] School of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand
[2] School of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand
[3] School of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand
* Correspondence: pattrarat.te@kmitl.ac.th

Citation:
Anuwong, C.; Kaewtaphan, P.; Teamkao, P. Optimizing organic fertilization for marguerite daisy *(Argyranthemum frutescens):* Impact of application rate and frequency on growth and yield. *ASEAN J. Sci. Tech. Report.* **2024**, *27*(5), e253200. https://doi.org/10.55164/ajstr.v27i5.253200

Article history:
Received: March 14, 2024
Revised: July 26, 2024
Accepted: August 8, 2024
Available online: September 7, 2024

Abstract: Edible flowers are a new market for horticulture plants. Beyond their attractive shapes and colors, this group of plants contains secondary metabolites that benefit human health. This study aims to investigate the growth and flower yield of marguerite daisies using organic fertilizer at different rates and frequencies. The experiment was designed as a factorial, completely randomized design with two factors: fertilizer rate (0.5, 1.0, and 1.5 times compared to the total nitrogen content in chemical fertilizer) and frequency of organic fertilizer application (every 30 and 15 days). Slow-release chemical fertilizer (Osmocote 13-13-13) was used as a control. The experiment reveals that the rate of organic fertilizer application significantly affected the growth and flower yield of marguerite daisy. Still, the frequency of organic fertilizer application did not significantly affect it. Application at 1.5 times yielded the most significant growth and flower production compared to 0.5 and 1 times of application. When comparing the results of organic fertilizer application with 13-13-13 chemical fertilizer, it was found that applying organic fertilizer 1.0 times and 1.5 times every 15 or 30 days resulted in similar plant growth and flower size as with the chemical fertilizer ($p>0.05$). However, chemical fertilizer produced the highest chlorophyll index (SPAD), accumulated flower buds, and flower blooming per pot ($p<0.05$). The plant requires more than 1.5 times the organic fertilizer application to achieve flower production equivalent to chemical fertilizer.

Keywords: Fertilizer ratios; Timing of fertilizer application; Optimum fertilizer; Edible flower

1. Introduction

Flowers are rich in natural antioxidants, including flavonoids, anthocyanins, and many other compounds [1,2]. The demand for flowers has increased due to their attractive colors, appearance, and taste, leading to their use in the perfume and food industries. Flowers used for culinary purposes, known as "edible flowers," have become more popular because of their aroma, texture, flavor, color, shape, and phytochemical composition [1,2]. Edible flowers are commonly used as garnish for salads, soups, desserts, and beverages. Examples of flowers used in this way include roses, marigolds, hibiscus, calendula, and daisy [3]. The genus *Argyranthemum* is a notable source of secondary metabolites. Maguerite daisy (*Argyranthemum frutescens*) exhibits antimicrobial activity against Gram-positive and Gram-negative bacteria and cytotoxic activity against HeLa and Hep-2 cell lines [4].

The traditional cultivation of edible flowers for food purposes relies on organic production. Organic production is a system that promotes and enhances the health and biodiversity of agroecosystems. Organic management practices combine traditional methods, innovation, and science to promote environmental and economic sustainability [5]. Moreover, organic production utilizes fewer additives and fertilizers to minimize hazards to consumers and environmental health. The nutrient sources in organic production rely on organic materials, both in fresh or dry form and composted materials. Manure, including urine from poultry, pigs, and cattle, is the primary source of nutrients from animal origin. To prevent nitrate contamination, farmyard manure, solid animal excrement, and liquid animal excrement should be used with care [6]. Composting organic materials into stable, humidified, and pathogen-free material is another source of nutrients in organic practices. Organic fertilizers made from organic materials release nutrients slowly. The application of organic fertilizer is usually done at sowing or transplanting stages.

Organic fertilizer improves soil physiochemical properties and increases total organic carbon, water-soluble carbon, and soil microbial diversity and activity [7, 8]. Applying bio-organic fertilizer at a rate of 10,000 kg/ka with micro-moistening irrigation resulted in greater net photosynthesis rate, water use efficiency, flower yield, and improved nutritional quality of edible rose compared to bio-organic fertilizer at a rate of 15,000 kg/ka with the same water supply method [9]. The split-split application of organic manure increased individual fruit weight over split and single-dose applications. The rate of organic manure application of 30 t/ha gave eggplant a higher number and fruit weight than a lower dose of organic manure (10 and 20 t/ha). However, the application of 30 t/ha gave the highest levels of vitamin B1 and B2, although this was not statistically different from 20 t/ha [10].

Presently, edible flowers are commonly grown soilless in potting media or hydroponically in greenhouses or outdoors. Typically, the controlled-release fertilizer Osmocote 13-13-13 is preferred for cultivating ornamental plants. This chemical fertilizer is re-applied every 2 or 3 months. Meanwhile, organic fertilizers contain nutrients mostly in organic form and act as slow-release fertilizers, providing nutrients in lower amounts over an extended period. Organic fertilizer could substitute for slow-release chemical fertilizer, potentially reducing production costs and nutrient leaching. The present study focuses on the growth and flower yield of marguerite daisy using organic fertilizer at different rates and frequencies of application.

2. Materials and Methods

2.1 Study area

The experiment was conducted under greenhouse conditions at the School of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand, from August to September 2023.

2.2 Experimental design

The experiment was designed as a factorial in a completely randomized design with two factors. The first factor was the rate of organic fertilizer application (5, 10, and 15 g/pot equal to 0.5, 1, and 1.5 times compared to the total nitrogen content in chemical fertilizer), and the second factor was the frequency of fertilizer application (every 30 and 15 days). A slow-release chemical fertilizer (Osmocote 13-13-13) was used as a control at a rate of 1 g/pot. The application rate and nutrient content in each treatment are presented in Table 1. The organic fertilizer was made from composted soybean meal, eucalyptus bark, and pineapple peel, with a ratio of 3:2:1 for 75 days. The compost was turned every week, and moisture was maintained at 60% until the end of the composting process. The pH was measured by a pH meter. Total organic matter was determined by the Walkley and Black method. Total nitrogen was determined using the Kjeldahl method. Total P_2O_5 was determined by the indirect method. Total K_2O was determined by the flame photometric method. CaO and MgO were determined using double acid digestion followed by the atomic adsorption spectrophotometric method. Total sulfur was measured using the turbidimetric method. The properties of the organic fertilizer are detailed in Table 2.

One-month-old marguerite daisy plantlets were transplanted into potting media, with two plantlets per 6-inch round black plastic pot. During transplanting, 70% of the organic fertilizer was applied, and the remaining 30% was applied every 30 or every 15 days according to the treatment. In contrast, the total amount of chemical fertilizer was applied at the time of transplantation. Daily watering was conducted, and the plants were grown for 60 days.

Table 1. Application rate and nutrient content for the treatments in the study.

Treatment	Fertilizer application (g/pot)				Total fertilizer application (g/pot)	Nutrient in fertilizer (g/pot)		
	Transplant	15 DAT*	30 DAT	45 DAT		N	P_2O_5	K_2O
0.5T_30D	3.5	0	1.5	0	5	0.065	0.025	0.05
0.5T_15D	3.5	0.5	0.5	0.5	5	0.065	0.025	0.05
1.0T_30D	7	0	3	0	10	0.13	0.05	0.1
1.0T_15D	7	1	1	1	10	0.13	0.05	0.1
1.5T_30D	10.5	0	4.5	0	15	0.195	0.075	0.15
1.5T_15D	10.5	1.5	1.5	1.5	15	0.195	0.075	0.15
13-13-13	1	0	0	0	1	0.13	0.13	0.13

* DAT = Day after transplanting

Table 2. Properties of organic fertilizer used in the study.

Parameter	pH	OM (%)	Total N (%)	Total P_2O_5 (%)	Total K_2O (%)	Total CaO (%)	Total MgO (%)	Total S (%)
Value	7.6	21.2	1.3	0.5	1.0	10.7	2.3	0.9

2.3 Plant growth and flower yield

The growth of marguerite daisy, including plant height and canopy diameter, was recorded in centimeters on days 30 and 60 of the experiment. The chlorophyll index (SPAD) was measured on fully expanded leaves using a Konica Minolta SPAD-502 Plus on days 30 and 60 of the experiment. The plants were cut at ground level, with the upper part as a shoot and the remaining part as a root. The fresh weight and dry weight (after oven-drying at 70°C for 48 hours) of both the shoot and root of the maguerite daisy were measured at the end of the experiment (day 60).

Flower bud and flower blooming were initially estimated one month after transplanting, and measurements were taken every week until 60 days after transplanting. The number of days until the first blooming was recorded, and flower diameter was measured using fully-bloomed flowers using a vernier caliper.

2.4 Statistical analysis

Analysis of variance (ANOVA) for the factorial design was conducted. Compared with chemical fertilizer, the comparison of means for interactions was estimated using Duncan's Multiple Range Test (DMRT) with a completely randomized design. All analyses were performed using SPSS 17.

3. Results and Discussion

3.1 Plant growth

The organic fertilizer application rate significantly affected every plant growth parameter, but the intensity of use did not affect plant growth (Table 3-4). The organic fertilizer application rate affected plant height, canopy diameter, SPAD, shoot, and root weight. Applying 1.5 times resulted in the most significant plant height, canopy diameter, and SPAD, although it was not statistically different from the results obtained with 1.0 times (Table 3). Furthermore, applying 1.5 times led to the highest shoot fresh and dry weights, followed by 1.0 and 0.5 times, respectively (Table 4). Additionally, the application of 1.0 times resulted in the highest root fresh and dry weight, although there was no statistical difference compared to the application of 1.5 times of organic fertilizer.

Applying a higher dose of organic fertilizer tended to decrease root weight (Table 4). This finding follows Bi and Evans [11], which found a reduction in the root rating of marigolds with high doses of broiler chicken litter-based organic fertilizer, 4-2-2, and 3-3-3, compared to low to medium doses. Moreover, the plants showed symptoms associated with excessive fertilization, possibly due to higher electrical conductivity. Nitrogen plays a crucial role in chlorophyll manufacture through photosynthesis, promoting green leafy growth, and supporting fruit and seed development—phosphorus aids in transferring energy throughout the plant, particularly for root development and flowering. Potassium is essential for photosynthesis and regulates numerous metabolic processes for growth and fruit and seed development. Greater applications of organic fertilizer also increase plant nutrient intake, leading to improved growth in line with the rate of application increment.

The frequency of use affected plant growth and biomass. A trend indicated that application every 30 days resulted in more significant plant growth except for root weight, which showed a trend toward higher values with application every 15 days. It appears that the rate of organic fertilizer application is more influential than the intensity of application. Nutrients in organic fertilizer are mainly organic, which undergoes slow mineralization for plant utilization. The release of available nitrogen from organic fertilizers varies depending on factors such as temperature, duration, the C/N ratio of the materials, and the stabilization process [12, 13]. For instance, final mineralized nitrogen from poultry manure can range from 3 to 75% [12]. Compost and vermicompost release nitrogen in the 4.0-16.5% range, with organic nitrogen mineralized at a lower rate (-0.9-7.7%) [13]. Nitrogen release can be observed in the 25-45% range during 35 days of incubation of organic fertilizers, such as turkey manure and mushroom substrate [14].

Table 3. Canopy diameter, plant height, and SPAD value of marguerite daisy fertilized with different rates and frequencies of organic fertilizer.

		Plant height (cm)		**Canopy diameter (cm)**		**SPAD**	
		30 DAT*	**60 DAT**	**30 DAT**	**60 DAT**	**30 DAT**	**60 DAT**
Fertilizer rate							
	0.5T	12.20 b	15.67 b	12.35 b	14.20 c	23.92 c	21.34 b
	1.0T	17.52 a	20.20 a	16.05 a	20.40 b	30.64 b	24.01 a
	1.5T	17.37 a	21.00 a	14.82 a	23.70 a	33.15 a	24.97 a
Frequency							
	30D	15.82	19.40	14.72	19.61	29.35	23.68
	15D	15.57	18.51	14.09	19.26	29.12	23.20
Fertilizer rate		**	**	**	**	**	**
Frequency		ns	ns	ns	ns	ns	ns
Fertilizer rate x Frequency		ns	ns	ns	ns	ns	ns
CV (%)		17.2	14.5	13.2	22.1	13.9	8.4

* DAT = Day after transplanting.
ns = non significant, **= significantly different at $p < 0.01$. Means within the same column followed by the same letter are not significantly different by DMRT.

3.2 Flower development

The organic fertilizer application rate significantly affected flower quality, but the application intensity did not. The application rate of 1.5 times resulted in the highest accumulation of flower buds per pot (84.5 buds), accumulated flowers blooming per pot (20.58 flowers), day-to-first flower blooming (9.17 days), and flower diameter (2.78 cm) (Table 5). This was followed by the application rates of 1.0 and 0.5 times, which were statistically different.

An increase in the organic fertilizer rate increased flower numbers and improved flower quality while reducing the time spent flowering. During the flowering or fruiting stage, higher phosphorus and potassium levels are required to support flower and fruit formation. Moreover, nitrogen affects the flower's life cycle, including vegetative and reproductive phases. Flower size, stem length, number of flowers per plant, and color were reduced by nitrogen deficiency. Therefore, achieving the optimum level of nitrogen supply in each growth stage is crucial for flower crop production [15]. Different plants have varying nutrient requirements at different stages of growth. During the vegetative stage, plants require higher nitrogen levels to promote leaf and stem development. Meanwhile, higher levels of phosphorus and potassium are needed to support flower and fruit formation during the flowering or fruiting stage.

Table 4. Shoot fresh weight, shoot dry weight, root fresh weight, and root dry weight of marguerite daisy fertilized with different rates and frequencies of organic fertilizer.

		Shoot weight (g)		Root weight (g)	
		Fresh weight	Dry weight	Fresh weight	Dry weight
Fertilizer rate					
	0.5T	3.69 c	1.19 c	3.61 b	1.34 b
	1.0T	9.22 b	2.77 b	9.39 a	3.39 a
	1.5T	16.14 a	4.38 a	7.53 a	2.23 ab
Frequency					
	30D	10.20	3.02	5.60	2.35
	15D	9.85	2.71	8.20	2.42
Fertilizer rate		**	**	**	**
Frequency		ns	ns	ns	ns
Fertilizer rate x Frequency		ns	ns	ns	*
CV (%)		60.3	51.4	47.8	55.2

ns = non significant, *= significantly different at $p < 0.05$, **= significantly different at $p < 0.01$. Means within the same column followed by the same letter are not significantly different by DMRT.

Table 5. The flower quality of marguerite daisy is fertilized at different rates and frequencies of organic fertilizer.

	Accumulate flower bud/pot (bud)	Accumulated blooming/pot (flower)	Day to blooming (day)	Flower diameter (cm)
Fertilizer rate				
0.5T	29.67 c	5.92 c	11.00 a	2.4 b
1.0T	58.41 b	15.50 b	11.83 a	2.64 a
1.5T	84.5 a	20.58 a	9.17 b	2.78 a
Frequency				
30D	56.39	14.16	10.61	2.67
15D	58.67	13.83	10.72	2.54
Fertilizer rate	**	**	*	**
Frequency	ns	ns	ns	ns
Fertilizer rate x Frequency	ns	ns	ns	ns
CV (%)	45.9	50.9	22.7	9.2

ns = non significant, *= significantly different at $p < 0.05$, **= significantly different at $p < 0.01$. Means within the same column followed by the same letter are not significantly different by DMRT.

3.3 Comparison between organic fertilizer and slow-released chemical fertilizer

The interaction between the rate and intensity of organic fertilizer application was compared with a slow-released chemical fertilizer (Osmocote 13-13-13) that is typically used in flower production for the growth of marguerite daisy over 60 days, as shown in Table 6. Application rates of 1 time and 1.5 times resulted in canopy diameter, shoot fresh and dry weight, root fresh weight, and dry weight that were not statistically different from those observed with chemical fertilizer use. Additionally, applying 1.5 times of organic fertilizer every 30 days resulted in greater plant height than chemical fertilizer application, with statistically significant differences. Chemical fertilizer application also led to higher SPAD values than organic fertilizer use. Furthermore, the application of organic fertilizer showed a yellower leaf color (Fig. 1). Lalk et al. [16] reported that conventional fertilizer (Osmocote® 15-9-12 applied 20 g/pot) resulted in higher values for plant growth, leaf SPAD, fruit yield, and photosynthetic rate with strawberries than organic fertilizer (5N-1.3P-3.3K applied 60 g/pot). Nutrients in organic fertilizers are in organic form and must mineralize for the nutrients to be available for plant uptake, resulting in a slow release of nutrients. Gaskell et al. [17] proposed that large quantities and continuous application of organic fertilizers are required to achieve certain fertility and soil organic matter levels for optimal yield in the organic farming of strawberries.

SPAD values were significantly correlated with nitrogen and phosphorus concentrations in grapevine leaves. In contrast, SPAD values were correlated with nitrogen, calcium, potassium, and magnesium levels in apples [18] and nitrogen and magnesium content in blueberry plants (*Vaccinium corymbosum* L.) [19]. A strong correlation was observed among SPAD readings, the total yield, and the marketable yield of sweet potatoes [20]. Leaf chlorophyll content at 79 days after sowing correlated well with rice grain yield [21].

Table 6. Growth comparison of marguerite daisy fertilized with different rates and frequencies of organic fertilizer compared with Osmocote 13-13-13.

Treatment	Canopy diameter (cm)	Plant height (cm)	SPAD	Shoot weight (g)		Root weight (g)	
				Fresh weight	Dry weight	Fresh weight	Dry weight
0.5T_30D	14.37 c	15.80 c	21.74 cd	4.07 b	1.30 c	2.86 b	1.61 b
0.5T_15D	14.03c	15.53 c	20.94 d	3.12 b	1.02 c	4.75 ab	0.94 b
1.0T_30D	20.13 b	20.13 ab	23.51 bc	9.25 ab	2.85 bc	9.74 a	4.03 a
1.0T_15D	20.67 ab	20.27 ab	24.50 b	9.20 ab	2.69 bc	9.04 a	2.75 ab
1.5T_30D	24.33 ab	22.27 a	25.77 b	17.29 a	4.90 a	5.40 ab	1.41 b
1.5T_15D	23.07 ab	19.73 b	21.17 b	14.98 a	3.86 ab	9.65 a	3.06 ab
13-13-13	24.93 a	19.87 b	30.36 a	9.73 ab	2.75 bc	9.51 a	2.93 ab
F-test	**	**	**	**	**	**	**
CV (%)	23.3	13.4	12.7	55.8	47.8	43.4	49.8

**= significantly different at $p < 0.01$. Means within the same column followed by the same letter are not significantly different by DMRT.

Applying chemical fertilizer resulted in the highest accumulation of buds and flowers per pot (Table 7). However, there was no statistically significant difference in flower diameter between chemical and organic fertilizers, except for the application rate of 0.5 times every 15 days (Table 7, Fig. 2). The day-to-first flower blooming did not show statistically significant differences between treatments. However, applying organic fertilizer 1.5 times every 15 days tended to have the fastest blooming rate.

Table 7. Flower comparison of marguerite daisy fertilized with different rates and frequencies of organic fertilizer compared with Osmocote 13-13-13.

Treatment	Accumulated bud/pot (bud)	Flower diameter (cm)	Accumulate blooming/pot (flower)	Day to blooming (day)
0.5T_30D	32.17 d	2.51 ab	6.67 d	10.17
0.5T_15D	27.17 d	2.28 b	5.17 d	11.83
1.0T_30D	51.83 c	2.75 a	15.83 bc	11.50
1.0T_15D	65.00 c	2.53 ab	15.17 c	12.1
1.5T_30D	85.17 b	2.74 a	20.00 bc	10.17
1.5T_15D	83.83 b	2.81 a	21.17 b	8.17
13-13-13	109.00 a	2.78 a	28.67 a	10.8
F-test	**	**	**	ns
CV (%)	48.0	12.7	54.2	22.9

ns = non significant, **= significantly different at $p < 0.01$. Means within the same column followed by the same letter are not significantly different by DMRT.

The lower flower yield of the organic fertilizer treatment compared to the chemical fertilizer may result from the different forms of nitrogen and lower phosphorus content of the organic fertilizer (Table 1). Nitrogen significantly affects plant growth and flower quality. Although the total nitrogen content in organic and chemical fertilizers is the same, they differ in their forms. Nitrogen in organic fertilizer mainly exists in the form of organic nitrogen, while Osmocote 13-13-13 contains nitrogen in the form of ammonium nitrogen (NH_4-N) at 7.6% and nitrate nitrogen (NO_3-N) at 5.4% [22]. The fertilizer takes 13.0 days and 10.7 days to release 50% of NH_4-N and NO_3-N, respectively. About 80% of NH_4-N and NO_3-N are released within 20 days. Additionally, 65% potassium and 35% phosphorus are released within 20 days [22]. On average, NH_4-N, NO_3-N, phosphorus, and potassium released from Osmocote 13-13-13 are 99.0, 108.7, 68.9, and 99.1%, respectively [22]. It is recommended to reapply Osmocote every 3 months. Niedzinski [14] reported that nitrogen release ranges from 25 to 45% during a 35-day incubation period for organic fertilizers (turkey manure and mushroom substrate), while mineral fertilizers release 55 to 95% of nitrogen.

Phosphorus is another limiting nutrient in organic fertilizer. The organic fertilizer contained 0.5% of P_2O_5, whereas Osmocote 13-13-13 contained 13% of P_2O_5. Phosphorus supports energy transfer throughout the plant for root development and flowering. The amount of phosphorus is related to various yield-governing parameters, such as the number of branches, flowers per plant, flower diameter, and flower weight in marigolds [23].

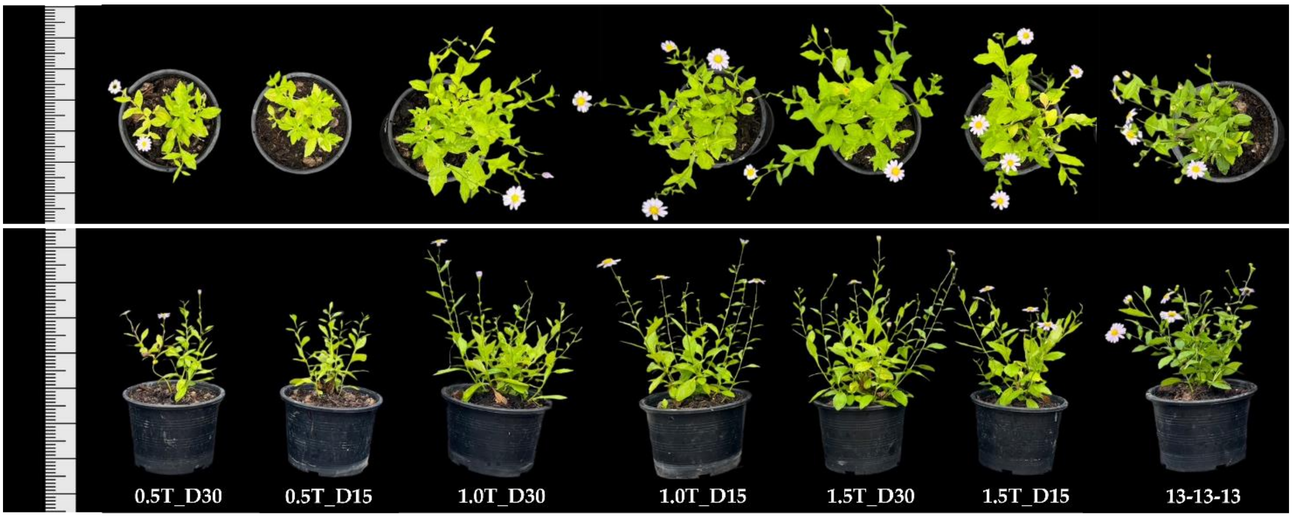

Figure 1. Characteristics of marguerite daisy growth during the experiment.

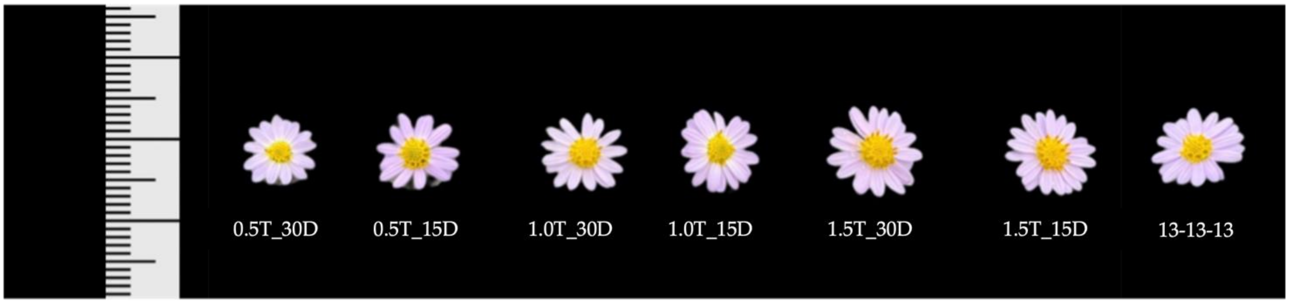

Figure 2. Size comparison of marguerite daisy flower growth with different treatments.

Plant nutrients play an essential role in growth and production. Fertilizers that provide nutrients in different forms and quantities produce varied plant growth and yields. Moreover, fertilizer is a factor that influences secondary metabolites in plants. Indian aster (*Kalimeris indica*) growing in biocomposite (derived from fruits and vegetables) exhibited higher contents of anthocyanins, flavonoids, sugars, organic acids, aldehydes, and alcohol compared to those grown in organic fertilizer derived from animal manure [24]. Furthermore, the flowers were more purple and had a fruity aroma, making them more attractive for consumption [24]. The quality of marguerite daisies, including secondary metabolites in flowers grown under organic production, requires further research.

In the present study, the application rate strongly affected marguerite daisy growth and flower yield. Applying 1.5 times the nitrogen content in slow-release chemical fertilizer resulted in similar growth and flower quality compared to chemical fertilizer. However, applying 1.5 times of organic fertilizer was inadequate to supply the flower yield and achieve a leaf SPAD level equal to chemical fertilizer. Therefore, more than 1.5 times of organic fertilizer may be required to increase flower yield, and it may be necessary to supplement with liquid fertilizer to increase phosphorus levels.

4. Conclusions

Plant nutrients play an essential role in growth and production. Fertilizers that provide nutrients in different forms and quantities produce varying plant growth and yields. The higher rate of organic fertilizer application increases marguerite daisy growth and flower yield, with the highest yield observed with 1.5 times application. The intensity of organic fertilizer application, whether every 30 days or every 15 days, did not affect the plant's growth and flower production. Applying organic fertilizer at 1.5 times the rate of Osmocote 13-13-13 resulted in similar growth and flower quality of marguerite daisy compared to chemical fertilizer. However, it yielded lower flower and leaf SPAD levels than chemical fertilizer. Suggestions indicate that applying more than 1.5 times the amount of organic fertilizer or supplementing with foliar application of bio-extract to increase nutrient supply could result in marguerite daisy growth and yield comparable to chemical fertilizer.

5. Acknowledgements

This research was supported by the School of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang. The author would like to thank Dr. Krichanont Iyapunya for providing the organic fertilizer material.

Author Contributions: Conceptualization, C.A., P.K., and P.T.; methodology, C.A., and P.T.; formal analysis, P.T.; investigation, C.A.; writing—original draft preparation, P.T.; writing—review and editing, P.T., C.A., P.K.

Funding: This research was funded by the School of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang.

Conflicts of Interest: The authors declare no conflict of interest.

References

[1] Prabawati, N.B.; Oktavirina, V.; Palma, M.; Setyaningsih, W. Edible flowers: antioxidant compounds and their functional properties. *Horticulturae*. **2021**, *7*(4), 66. https://doi.org/10.3390/horticulturae7040066

[2] Purohit, S.R.; Rana, S.S.; Idrishi, R.; Sharma, V.; Ghosh, P. A review on nutritional, bioactive, toxicological properties and preservation of edible flowers. *J. Future Foods.* **2021**, *4*, 100078. https://doi.org/10.1016/j.fufo.2021.100078

[3] Netam, N. Edible flower cultivation: A new approach in floriculture industry. *The Pharma Innovation Journal*. **2021**, *10*(3), 857-859. https://doi.org/10.22271/tpi.2021.v10.i3l.5896

[4] Gonzalez, A.G.; Estevez-Reyes, R.; Estevez-Braun, A.; Ravelo, A.G.; Jimenez, I.A.; Bazzocchi, I.L.; Aguilar, M.A.; Moujir, L. Biological activities of some Argyranthemum species. *Phytochemistry*. **1997**, *45*(5), 963-967. https://doi.org/10.1016/S0031-9422(97)00063-0

[5] Fernandez, J.A.; Ayastuy, M.E.; Belladonna, D.P.; Comezana, M.M.; Contreras, J.; Mourao, I.M.; Orden, L.; Rpdriguez, R.A. Current trends in organic vegetable crop production: practices and technique. *Horticulturae*. **2022**, *8*, 893. https://doi.org/10.3390/horticulturae8100893

[6] Jones. C.S.; Drake, C.W.; Hruby, C.E.; Schilling, K.E.; Wolter, C.F. Livestock manure driving stream nitrate. *Ambio*. **2019**, *48*(10), 1143-1153. https://doi.org/10.1007/s13280-018-1137-5

[7] Singh, V.; Sharma, S.; Kumar, P.; Bhardwaj, S.; Gautam, H. Conjoint application of bio-organic and inorganic nutrient sources for improving cropping behaviour, soil properties and quality attributes of apricot (*Prunus armeniaca*). *Indian J. Agric. Sci.* **2010**, *80*, 981-987.

[8] Wang, J.; Li, X.; Xing, S.; Ma, Z.; Hu, S.; Tu, C. Bio-organic fertilizer promotes plant growth and yield and improves soil microbial community in continuous monoculture system of *Chrysanthemum morifolium* cv. Chuju. *Int. J. Agric. Biol.* **2017**, *19*, 563-568. https://doi.org/10.17957/IJAB/15.0339

[9] Liu, X.; Zhang, Y.; Jiang, Z.; Yue, X.; Liang, J.; Yang, Q.; Li, J.; Li, N. Micro-moistening irrigation combined with bio-organic fertilizer: An adaptive irrigation and fertilization strategy to improve soil

environment, edible Rose yield, and nutritional quality. *Ind. Crops Prod*. **2023**, *196*, 116487. https://doi.org/10.1016/j.indcrop.2023.116487

[10] Agbo, C.U.; Chukwudi, P.U.; Ogbu, A.N. Effects of rates and frequency of application of organic manure on growth, yield and biochemical composition of *Solanum melongena* L. (cv. "Nawa local") fruits. *J Anim Plant Sci.* **2012**, *14* (2), 1952-1960.

[11] Bi, G.; Evans, W.B.; Spiers, J.M.; Witcher, A. Effects of organic and inorganic fertilizers on marigold growth and flowering. *Hort. Science*. **2010**, *45*(9), 1373-1377. https://doi.org/10.21273/HORTSCI.45.9.1373

[12] Geisseler, D.; Smith, R.; Cahn, M.; Muramoto, J. Nitrogen mineralization from organic fertilizers and composts: Literature survey and model fitting. *J. Environ. Qual.* **2021**, *50*(6), 1325-1338. https://doi.org/10.1002/jeq2.20295

[13] Vione, E.L.B.; Drescher, G.L.; da Silva, L.S.; Giacomini, S.J.; Aita, N.T.; da Silva, A.A.K.; Prigol, L.H.F. Nitrogen mineralization of compost and vermicompost from different animal manure and its recovery by lettuce using 15N. *SSRN*. **2023**. http://dx.doi.org/10.2139/ssrn.4385890

[14] Niedzinski, T.; Sierra, M.J.; Labetowicz, J.; Noras, K.; Cabrales, C.; Millan, R. Release of nitrogen from granulate mineral and organic fertilizers and its effect on selected chemical parameters of soil. *Agronomy*. **2021**, *11*, 1981. https://doi.org/10.3390/agronomy11101981

[15] Ruamrungsri, S.; Panjama, K.; Ohyama, T.; Inkham, C. Nitrogen in flowers. In T. Ohyama & K. Inubushi (Eds.), *Nitrogen in Agriculture*. IntechOpen. 2021. https://doi.org/10.5772/intechopen.98273

[16] Lalk, G.T.; Bi, G.; Stafne, E.T.; Li, T. Fertilizer type and irrigation frequency affect plant growth, yield, and gas exchange of containerized strawberry cultivars. *Technology in Horticulture*. **2023**, *3*, 1-8. https://doi.org/10.48130/TIH-2023-0003

[17] Gaskell, M.; Bolda, M.P.; Muramoto, J.; Daugovish, O. Strawberry nitrogen fertilization from organic nutrient sources. *Acta Hortic*. **2009**, *842*, 385-88. https://doi.org/10.17660/ActaHortic.2009.842.74

[18] Porro, D.; Dorigatti, C.; Stefanini, M; Ceschini, A. Use of SPAD meter in diagnosis of nutritional status in apple and grapevine. *Acta Hortic*. **2001**, *564*, 243-252. https://doi.org/10.17660/ActaHortic.2001.564.28

[19] Pinzón-Sandoval E.H.; Balaguera-López, H.E.; Almanza-Merchán, P.J. Evaluation of SPAD index for estimating nitrogen and magnesium contents in three blueberry varieties (*Vaccinium corymbosum* L.) on the Andean Tropics. *Horticulturae.* **2023**, *9*, 269. https://doi.org/10.3390/horticulturae9020269

[20] Pepó, P. Correlation analysis of the SPAD readings and yield of sweet potato (*Ipomoea batatas L.*) under different agrotechnical conditions. *Aust. J. Crop Sci*. **2020**, *14*(05), 761-765. https://doi.org/10.21475 /ajcs.20.14.05.p2124

[21] Ramesh, K.; Chandrasekaran, B.; Balasubramanian, T.; Bangarusamy, U.; Sivasamy, R.; Sankaran, N. Chlorophyll dynamics in rice (*Oryza sativa*) before and after flowering based on SPAD (chlorophyll) meter monitoring and its relation with grain yield. *J. Agron. Crop Sci*. **2002**, *188*, 102-105. https://doi.org/10.1046/j.1439-037X.2002.00532.x

[22] Broschat, T.K.; Moore, K.K. Release rates of ammonium-nitrogen, nitrate-nitrogen, phosphorus, potassium, magnesium, iron, and manganese from seven controlled-release fertilizers. *Commun. Soil Sci. Plant*. **2007**, *38*, 843-850. https://doi.org/10.1080/00103620701260946

[23] Dangi., S.P.; Aryal, K.; Magar, P.S.; Bhattarai, S.; Shrestha, D.; Gyawali, S.; Basnet, M. Study on effect of phosphorus on growth and flowering of marigold (*Tagetes erecta*). *JOJ Wildl Biodivers.* **2019**, *1*(5), 555571. https://doi.org/10.19080/JOJWB.2019.01.555571

[24] de Morais, J.S.; Cabral, L.; da Costa, W.K.A.; Uhlmann, L.O.; Lima, M.S.; Noronha,M.F.; dos Santos, S.A.; Madruga, M.S.; Olegario, L.S.; Wagner, R.; Sant'Ana, A.S.; Magnani, M. Chemical and volatile composition, and microbial communities in edible purple flowers (*Torenia fournieri* F. Lind.) cultivated in different organic systems. *Food Res. Int*. **2022**, *162*, 111973. https://doi.org/10.1016/j.foodres.2022.111973