EFFECT OF ALTERNATIVE NUTRIENT SUPPLEMENTS ON THE GROWTH AND FLOWERING OF MARIGOLD (*CALENDULA OFFICINALIS* L.)

Judit CSABAI[1] –Anzhela KOLESNYK[2] – Beatris KISH[2]- Alexandra GRISECHKINA[2] - Antonina MENDEL[2] - Katalin IRINYINÉ OLÁH[1] – Mónika Fanni TÓTH[1] – Béla SZABÓ[1] – Mohamed TAREK[1]–Attila BALOGH[3] – Andrea GYÖRGYINÉ KOVÁCS[4]- Edit KOSZTYUNÉ KRAJNYÁK[1]

[1]University of Nyíregyháza, Sóstói str. 31/b, csabai.judit@nye.hu
[2]Uzhhorod National University, angela.kolesnyk@uzhnu.edu.ua
[3]Veterinary Laboratory of Baromfi-Coop Ltd.
H-4537 Nyírkércs, Petőfi u. 41. balogha@baromficoop.hu
[3]University of Debrecen, IAREF, Nyíregyháza, Westsik Vilmos str .4-6
https://doi.org/10.71066/FTTMK.1.13

Abstract

We investigated the effects of pruning *Calendula officinalis* and the application of three different soil improvement materials: rhyolite, pelletized poultry manure, and flocculant. In the pruning experiment, four rows of marigold seedlings were planted. The highest number of flowers was recorded in July (641 pcs), which then dropped to 129 pcs after pruning. The average flower diameter in the non-pruned rows ranged between 3.53 and 3.54 cm, while in the pruned rows it was only 3.00 to 3.16 cm. Based on the measurements, it was concluded that the regeneration period following pruning led to a temporary decrease in total yield.

In the fertilization experiment, 640 seedlings were planted across two plots. In June, the rhyolite-treated rows produced the highest fresh flower weight (on average 12.42 g/row), while in July, the application of the flocculant resulted in the highest yield (average 488.6 g), compared to 362 g in the control. In August, the poultry manure rows produced 467.25 g, and the flocculant-treated rows yielded 487.33 g. On a yearly scale, the highest cumulative yield was observed in the flocculant-treated plants, averaging 980.76 g per row. The results suggest that the use of flocculant had a positive long-term effect on flower production in marigold, while pruning should be applied only purposefully and with proper timing.

Key words: rhyolite, poultry manure, flocculant, yield, flower size, medicinal plant

Introduction

The Mediterranean annual plant *Calendula officinalis* L., popularly known as marigold, has long been used for both medicinal and cosmetic purposes. It has antioxidant, wound-healing, and anti-inflammatory properties, mostly flavonoids and carotenoids. The plant can be successfully cultivated throughout Hungary. Germination begins at temperatures as low as 8–10 °C. Regular harvesting of the flowers stimulates the development of new flower heads, ensuring continuous yield until the first frosts (Treben, 1985; Bernáth et al. 2014, Zámboriné & Bernáth, 2003).

Sowing typically takes place in March, with a row spacing of 40–50 cm and plant spacing of 5–8 cm. The seed requirement is 6–10 kg/ha (Bernáth et al. 2014). Soil preparation involves deep plowing in the autumn, followed by crumbling and firming in the spring. Recommended base fertilization includes 40–60 kg/ha nitrogen, 60–80 kg/ha phosphorus, and 80–100 kg/ha potassium. Organic manure is not advised by several literatures, as it tends to stimulate vegetative growth at the expense of flower development (Lelesz, 2016; Molnár, 2024).

Harvesting of the drug parts is performed manually. Only the valuable floral parts should be collected, since the inclusion of other parts lowers product quality and increases processing costs (Böszörményi, 2017). Drying is carried out at 35–40 °C. Average yields are 1–1.2 t/ha (with calyx), and 0.3–0.4 t/ha for the petals alone (Bernáth et al. 2014, Zámboriné & Bernáth, 2003).

Quality control must follow ISO standards and the specifications of the Hungarian Pharmacopoeia (Ph. Hg. VIII., Bernáth, 2000).

Marigold drug products are freely marketable and widely used, for example, in teas, food flavorings, and skincare formulations (Darvas & Magyary-Kossa, 2021).

Materials and methods

The experiment was conducted at the demonstration garden of the Institute of Engineering and Agricultural Sciences, University of Nyíregyháza. The soil type was sandy loam with an Arany-type cohesiveness index of 31, slightly alkaline pH (7.29), and a humus content of 2.1% (Csabai et al. 2021; Csabai et al. 2022a). The soil's nutrient supply was deemed good since it contained sufficient amounts of phosphorus (339 mg/kg), potassium (183 mg/kg), nitrite-nitrate (19.1 mg/kg), and micronutrients like manganese (28.4 mg/kg) and zinc (11.67 mg/kg).

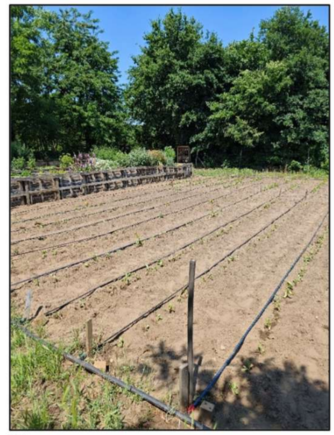
In 2023, June saw a slight increase of +0.4°C, still within the range of climatic stability, while May was somewhat colder (–0.2°C). The anomalies for July and August were +1.1°C and +2.5°C, respectively. The deviation increased to +3.9°C by September, a very high value that demonstrated the local effects of global warming. In 2023, precipitation was also erratic, with consistently below-average rainfall in May, June, and August. September had a recorded "zero" value even though there was no discernible deviation. These figures highlight the growing frequency and severity of weather extremes, which directly influence the success of agricultural production (Makszim & Soós, 2025). Meteorological conditions were monitored by the garden's own weather station.

Fertilization Effect Trial

Two plots, designated A and B, were used to transplant 640 marigold seedlings in the nutrient effect trial, which was carried out on May 27, 2024. There were 40 plants in each of the 8 rows that made up each plot, spaced 50 cm apart and 10 cm apart within rows. Each row received a different soil amendment, such as rhyolite, pelletized poultry manure, food industry side product flocculant, and control (no treatment) (Barta-Körmendy, 2007; Fülei, 2016; Köhler, 2006; Szabó et al. 2012; Csabai et al. 2022b; Kosztyuné et al. 2024). The plots' rows were identified by their clear labels, such as A1–A8 and B1–B8. For each row, the fresh and dry weight of the harvested flower heads, as well as their diameter, were measured (Figure 1).

Rhyolitic tuff acts as a physical, chemical, and biological soil improver, with an effective lifespan of 8–10 years (Köhler, 2006). Poultry manure provides rapidly absorbable nutrients (Kádár, 2013). The flocculant composed primarily of activated carbon and bentonite, enhances soil water retention and reduces contamination levels (Havassy, 2007).

(A)



(B)

Figure 1. Images of the experimental site (left: Plot A, right: Plot B). Source: Own photograph

Measured Parameters, Measurement Times and Frequency

The experiments involved evaluating the development and performance of the plants by measuring the fresh weight of harvested flower heads (g). Weekly records were maintained for the quantity and weight of flowers at each harvest. Immediately following collection, fresh flower heads were weighed and subsequently dried at room temperature. The drying period typically ranged from 7 to 14 days, contingent upon the moisture content and condition of the flowers. Data were recorded manually and subsequently summarized and averaged for each row. The collected data were subsequently processed for comparative evaluation and visualized graphically.

Results

During the experiment conducted in the demonstration garden of the University of Nyíregyháza, various soil-improving materials, rhyolite, pelletized poultry manure, and food industry flocculant, were applied to the rows of plots A and B. Based on the measurements, it was observed that flowering was more intense in the rhyolite- and poultry manure-treated rows, especially during the initial period, compared to the control rows.

In June, the rows treated with rhyolite produced the highest fresh flower weight, with an average of 12.42 g, while the control value was only 7.7 g (Figure 2). However, in terms of dry flower weight, the poultry manure-treated rows showed the highest values, and their flower diameters also exceeded those of the other treatments.

In July, the most positive effect on flower yield was observed with the flocculant treatment, which resulted in an average yield of 488.6 g, compared to 362 g in the control (Figure 3). However, flower diameter did not differ significantly between treatments during this period.

In August, both poultry manure (467.25 g) and flocculant (487.33 g) again produced the best results. The flocculant not only increased the total flower weight but also improved the flower diameter (Figure 4).

Based on the annual average yield, the flocculant treatment was the most effective, resulting in a total flower mass of 980.76 g (Figure 5), surpassing the results of all other treatments. These findings indicate that flocculant was the most beneficial soil amendment throughout the experiment, particularly during the second half of the growing season.

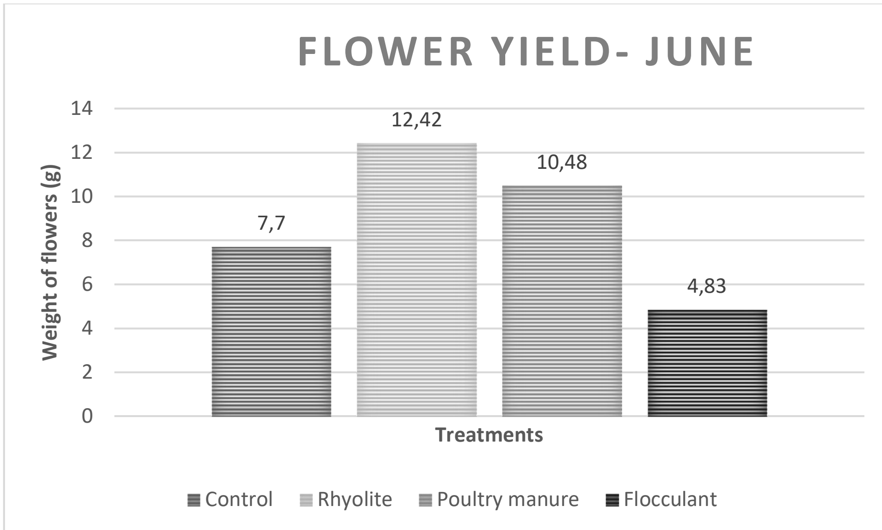


Figure 2. Average flower yield by treatment in June

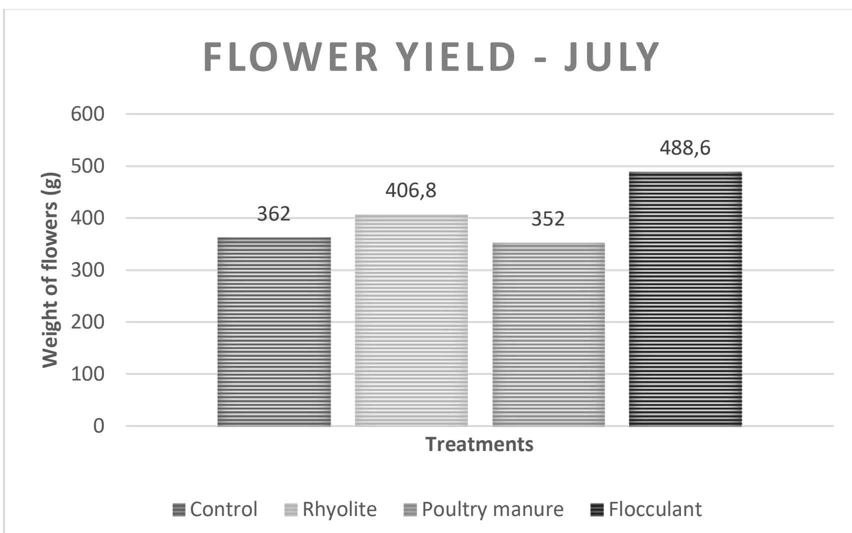


Figure 3. Average flower yield by treatment in July

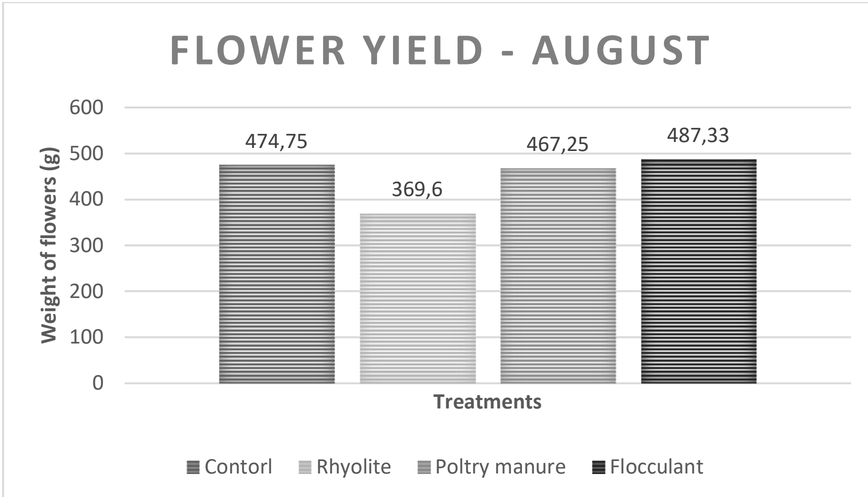


Figure 4. Average flower yield by treatment in August

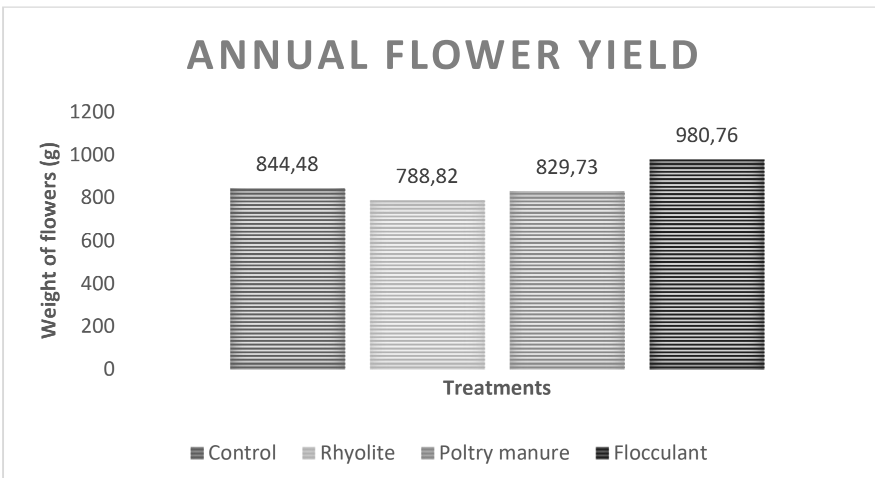


Figure 5. Average flower yield by treatment in the vegetation period

Conclusion

The soil amendment trial results indicate that all three treatments—rhyolite, pelletized poultry manure, and food industry flocculant—positively affected the flowering of Calendula officinalis, albeit with variations in intensity and timing. Poultry manure and rhyolite demonstrated greater effectiveness in the initial phases of plant development, whereas the flocculant treatment exhibited enhanced efficacy in the latter half of the growing season.

The flocculant treatment demonstrated the most balanced and consistent enhancement in flowering intensity, flower mass, and flower diameter across the entire vegetation period. It also enhanced the overall vitality of the plants.

The observations indicate that flocculant could function as a sustainable and effective soil amendment in marigold cultivation, particularly in long-term applications. Rhyolite and poultry manure are more effective in promoting early growth phases. The analysis of treatments underscores the sensitivity of marigold to soil nutrient composition, suggesting that precise and timely interventions can markedly enhance cultivation results.

Acknowledgements

The authors gratefully acknowledge the support of the CEEPUS program, which enabled student and staff mobility and thereby made the joint research and publication possible.
The publication received support from project 2022-1.2.2-TÉT-IPARI-UZ-2022-00023, AL-6222052520 "Supporting organic and conventional farming with Geospatial methods," funded by the NKFI (NRDI), Hungary, and the Innovative Development Agency, Uzbekistan. We gratefully acknowledge our project partner, Baromfi-Coop Ltd., for their support and for providing the experimental material used in this study.

References

Barta J. - Körmendy I.: 2007. Növényi nyersanyagok feldolgozástechnológiai műveletei Mezőgazda Kiadó Budapest pp 183, 184.

Bernáth J.: 2000. Gyógy- és aromanövények. Mezőgazda Kiadó, Budapest.

Bernáth J. – Czirbus Z. – Zámboriné Németh É.: 2014. Gyógynövények gyűjtése és termesztése (Képzési segédlet). Budapest: Gyógynövény Szövetség és Terméktanács.

Böszörményi A.: 2017. Gyógynövények gyűjtése, termesztése, nemesítése, feldolgozása. Semmelweis Egyetem, Farmakognóziai Intézet.
https://semmelweis.hu/farmakognozia/files/2017/02/Gynovenyek_termesztese_gyujtese_feldolg_BA.pdf

Csabai J. – Braun B. – Tarek M. – Oláh K. I.: 2021. Effect of alternative nutrient replenishes on soil quality parameters. Науковий вісник Ужгородського університету. Серія Біологія, (50-51), 41-47.

Csabai J. – Braun B. – Hörcsik Zs. T. – Kolesznyk A. – Irinyiné Oláh K.: 2022a. Alternatív trágyaszerek és szerkezetjavító anyagok hatása, a talaj fizikai és kémiai tulajdonságaira. In: Bujdosó, Zoltán (szerk.) XVIII. Nemzetközi Tudományos Napok [18th International Scientific Days]: A „Zöld Megállapodás" – Kihívások és lehetőségek. Gyöngyös, Magyarország : Magyar Agrár- és Élettudományi Egyetem Károly Róbert Campus. pp. 122-128. , 7 p.

Csabai, J. – Opitz, G. – Vaskó, B. – Aka Sağliker, H. – Kolesznyk, A. – Makszim Györgyné, N. T.: 2022b. Effects of alternative organic fertilizers on morphological parameters and yield of the sweet potato cultivar 'Ásotthalmi-12'. In: Irinyiné Oláh, K., Kosztyuné Krajnyák, E., & Szabó, B. (Eds.), Fenntartható Tápanyag-gazdálkodási Tudományos Műhely Konferenciája 2022: Innovatív megoldások a XXI. század mezőgazdaságában (pp. 56–63). Nyíregyháza: Nyíregyházi Egyetem, Műszaki és Agrártudományi Intézet.

Darvas F. - Magyary-Kossa Gy.: 2021. Hazai Gyógynövények, Termelésük, Értékesítésük, Hatásuk és Orvosi Használatuk. Nemzeti örökség kiadó.

Fülei Z.: 2016. Összhangban a Természettel, Istállótrágya helyett. Őstermelő Gazdálkodók lapja. 2016. 10. 05. http://ostermelo.com/osszhangban-a-termeszettel-istallotragya-helyett

Havassy A.: 2007. A bányászat története Komlóskán. Bányászattörténeti Közlemények - 3. = 2. évf. (2007.) 1. http://epa.oszk.hu/01400/01466/00003/pdf/03.pdf

Kádár I.: 2013. Szennyvizek, iszapok, komposztok, szervestrágyák a talajtermékenység szolgálatában. MTA ATK Talajtani és Agrokémiai Intézet, Budapest

Kosztyuné Krajnyák, E. – Szabó, B. – Kovács, Z. – Makszim Györgyné Nagy, T. – Györgyiné Kovács, A. – Csabai, J. – Abdurahmanov, I. – Abdurakhmonov, Z.: 2024. The effect of fermented poultry manure on the yield and quality parameters of triticale (X Triticosecale Wittmack) cultivated organic way on acidic sandy soil. E3S Web of Conferences, 590, 01009. https://doi.org/10.1051/e3sconf/202459001009

Köhler M.: 2006. Mire jó a riolittufa? Oktatási jegyzet. Debreceni Egyetem, Agrártudományi Centrum.

Lelesz J. É. – Csajbók J.: 2016. Relationship investigation between the marigold (Calendula officinalis L.) essential oil agents and quantitative presences change under different fertilization settings. Natural Resources and Sustainable Development, 8 (1), 93–98.

Makszim Gy. N. T. – Soós A.: 2025. Land Sharing and Land Sparing in Agriculture – Can We Change Our Attitudes? Eurochoices 24 : 1 pp. 43-49. , 7 p.

Molnár F.: 2024. Az eltérő tápanyagellátás hatása a körömvirág (Calendula officinalis L.) élettani és produkcióbiológiai jellemzőire. Diplomamunka. II. Rákóczi Ferenc Kárpátaljai Magyar Főiskola, Beregszász.Elérhető: https://dspace.kmf.uz.ua/jspui/bitstream/123456789/4090/4/Molnar_Ferenc_Az_eltero_tapanyagellatas_hatasa_a_koromvirag_Calendula_officinalis_L_elettani_es_produkciobiologiai_jell.pdf

Pharmacopoea Hungarica VIII: 2003. Hungarian Pharmacopoeia VIII. Budapest: National Institute of Pharmacy

Szabó B. – Szabó M. – Varga Cs. – Vágvölgyi S. Simon L.: 2012. A riolittufa hatása az energiafűz növekedési tulajdonságaira. XXXIV. ÓváriTudományos Nap – Magyar mezőgazdaság – lehetőségek, források, új gondolatok. Mosonmagyaróvár, 2012. október 5., p. 471.-476., CD kiadvány ISBN 978-963-9883-93-2

Treben, M. (1985). Füveskönyv – Egészség Isten patikájából (ford. P. Kovács Klára). Budapest: Magyar Könyvklub.

Zámboriné N. É. – Bernáth J.: 2003. Gyógy- és aromanövény hungarikumok megőrzése és fejlesztése. Kertgazdaság, 35 (1), 105–110.