



Effect of Spraying Salicylic Acid and Cycocel on Some Vegetative and Floral Traits of *Petunia hybrida* L.

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ABSTRACT

Background: Plant growth regulators are organic, non-food compounds that are used in small quantities to stimulate, inhibit, or modify physiological processes in plants.

Methods: The experiment was conducted in the lath house of the Agricultural Research and Experimental Station, University of Kirkuk, Kirkuk Governorate-Iraq, during the period from 2 December 2024 to 1 June 2025, to investigate the effect of foliar spraying with Salicylic acid at concentrations of (0, 250 and 500) mg L⁻¹ and Cycocel at concentrations of (0, 250 and 500) mg L⁻¹ on some vegetative and floral growth traits of *Petunia* (*Petunia hybrida* L.). The experiment was arranged according to a randomized complete block design (R.C.B.D).

Result: The results were analyzed using Duncan's Multiple Range Test at a probability level of 0.05. The results indicated that spraying with Salicylic acid at a concentration of 500 mg L⁻¹ significantly increased plant height and produced the highest number of leaves per plant and flower diameter. In contrast, the growth retardant Cycocel, when applied at a concentration of 500 mg L⁻¹, reduced plant height. Furthermore, both concentrations (500 and 250 mg L⁻¹) significantly affected the number of leaves, number of branches, number of flowers and flower diameter compared with the control treatment.

Key words: Cycocel, Ornamental plant, *Petunia hybrida* L., Plant growth regulators, Salicylic acid.

INTRODUCTION

Petunia hybrida L. It is one of the winter annual ornamental plants known in Iraq, belongs to the Solanaceae family. It features a trailing herbaceous stem and its leaves are simple, opposing or alternating (Al-Dajawi, 2004). Producing seeds is how *Petunia* propagates between Spring and Fall, with successful growth during both summer and winter (Al-Sultan *et al.*, 1992). Well-branched, cultivars can be medium or short in size, they are available in many colors, such as white, red, purple and pink, *Petunia* flowers bloom in spring to summer and the floral varies among the *Petunia* types in terms of shapes as well as sizes, the plant is a primary for the front beds of garden centers, with dwarf cultivars being ideal for use plants within central circular beds or along edges of flower beds. Some cultivars are also grown in hanging baskets (Al-Baali and Shendy, 1978).

Salicylic acid (ortho-hydroxybenzoic acid or 2-hydroxybenzoic acid) HOC₆H₄COOH is one of the present endogenous plant growth regulators that are phenolic compound in nature. It governs various key physiological and biochemical pathways taking place in plants like ion absorption, it also has an effect on stomata movement and ethylene biosynthesis. In addition, it shows antagonistic action to the leaf-abscission-inducing growth inhibitor, abscisic acid, moreover, it is involved in to speed up photosynthesis (Hayat and Ahmad, 2007; Al-Fatlawi *et al.*, 2021). Salicylic acid also increases plant tolerance of environmental stresses including high temperature, freezing, drought and salinity (Zarghami *et al.*, 2014).

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Hassan (2013) showed how to spray a plant (*Calendula officinalis* L.) with Salicylic acid at a concentration of 50 mg L⁻¹ enhanced fresh and dry weights of vegetative growth, petal numbers and flower fresh weight was reported, Salicylic acid can also significantly improve for stem length, stem diameter, branching levels, flower number, flower diameter, also the treatment with salicylic acid at a concentration of 150 mg L⁻¹ induced significant increase in plant height, average number of leaves, dry weight of the vegetative growth and number of inflorescences.

Cycocel (CCC) is one of the plant growth retardants commonly used in the treatment of potted plants and some ornamental plants. It reduces stem elongation by inhibiting

cell division and affects flowering due to its influence on endogenous gibberellins (Saleh and Abdul, 1980; Al-Mohammed, 1990; AL-Qadi *et al.*, 2020; Taha and Ali, 2025). Similarly, in an experiment conducted by (Singh *et al.*, 2018), spraying chrysanthemum (*Dendranthema grandiflora* Ramat.) with Cycocel at concentrations of (0, 1000, 5000 and 10000) ppm showed that the application of 5000 ppm caused a significant reduction in plant height, while significantly increasing the number of leaves, number of branches and the diameter of the main stem. It also recorded the highest number of flowers per plant, flower stalk length, flower size. The present study aimed to investigate the response of certain vegetative growth and flowering traits of petunia (*Petunia hybrida* L.) to different concentrations of Salicylic acid and Cycocel.

MATERIALS AND METHODS

The study was conducted in the lath house of the Department of Horticulture and Landscape design, University of Kirkuk, Agricultural Research and Experimental Station, Kirkuk Governorate-Iraq, during the period from 2 December 2024 to 1 June 2025. The pots used for planting seedlings were filled with a growth medium composed of a 2:1 mixture of soil and peat moss. Seedlings were transplanted on 3 December 2024 from plastic pots with a diameter of 10 cm to larger plastic pots with a diameter of 20 cm, each containing 6.5 kg of soil. Seedlings were sprayed with Cycocel at concentrations of 0, 250 and 500 mg L⁻¹ in three applications. The first spray was applied on 6 December 2024, the second on 21 December 2024 and the third on 4 January 2025. Salicylic acid was applied in two sprays at concentrations of 0, 250 and 500 mg L⁻¹. The first spray was applied on 12 December 2024, one week after the first Cycocel application and the second spray was applied on 18 December 2024, one week after the first salicylic acid spray. The experiment was conducted as a factorial experiment following a randomized complete block design (R.C.B.D) with three blocks, nine treatments and three replicates per experimental unit, resulting in a total of 81 plants, which were randomly distributed across the blocks (Al-Rawi and Abdul-Aziz, 1980). Data were analyzed using Duncan's Multiple Range Test at a probability level of 0.05. The studied traits were measured at the stage of flower color appearance and included the following (Al-Bayati and Salih, 2021).

Vegetative growth traits

Plant height (cm), Number of leaves plant⁻¹, Total leaf chlorophyll content and Number of branches plant⁻¹.

Floral growth traits

Number of flowers plant⁻¹, flower diameter (cm) and flowering duration (day).

RESULTS AND DISCUSSION

Plant height (cm)

As shown in Fig (1a), foliar spraying with Salicylic acid had a significant effect on increasing plant height, particularly at concentrations of 500 and 250 mg L⁻¹, which reached 18.977 and 19.733 cm, respectively. These values were significantly higher than the control treatment, which recorded 17.134 cm. This increase can be attributed to the role of Salicylic acid in enhancing vegetative growth by increasing auxin and cytokinin contents (Shakirova *et al.*, 2003), which in turn promote plant height. These results are consistent with those reported by (Fadel *et al.*, 2015) in their study on carnation (*Dianthus caryophyllus* L.) and (Al-Fatlawi *et al.*, 2021). Regarding the growth retardant Cycocel, as shown in Fig (1b), it had a significant effect in reducing plant height, with the lowest value of 16.077 cm recorded at a concentration of 500 mg L⁻¹. This value was significantly lower than the control treatment, which recorded the highest height of 21.775 cm. These findings agree with the results reported by (Soniya *et al.*, 2024). It was reported that spraying chrysanthemum (*Dendranthema grandiflorum*) with Cycocel at a concentration of 2000 mg L⁻¹ reduced plant height. The two-way interaction between the factors, as shown in Fig (1c), had a significant effect on increasing plant height. The highest value of 25.000 cm was recorded when salicylic acid at 250 mg L⁻¹ was combined with the control treatment of Cycocel. This increase is attributed to the positive effect of Salicylic acid. In contrast, the lowest height of 14.220 cm was observed when Salicylic acid was combined with Cycocel at 500 mg L⁻¹, which reflects the growth-retarding effect of Cycocel in reducing plant height (Saleh and Abdul, 1980; Guin *et al.*, 2025).

Number of leaves (leaves plant⁻¹)

The results presented in Fig (2a) and (2b) showed a significant superiority of both factors in the number of leaves. Salicylic acid at a concentration of 500 mg L⁻¹ produced the highest number of leaves, reaching 62.556 leaves per plant, compared to the control treatment, which recorded the lowest value of 50.00 leaves per plant. This increase can be attributed to the role of salicylic acid as a growth regulator that stimulates enzymes responsible for photosynthesis, accelerating this process and increasing the production of assimilates, which in turn promotes a higher number of leaves per plant (Hayat and Ahmad, 2007). These results are consistent with (Abdullah *et al.*, 2019), who reported that spraying chrysanthemum with Salicylic acid at 150 mg L⁻¹ significantly increased the number of leaves and with the findings of (Al-Fatlawi *et al.*, 2021). Regarding Cycocel spraying, concentrations of 250 and 500 mg L⁻¹ resulted in the highest number of leaves 58.778 and 59.889 leaves per plant, respectively, compared with the control treatment. This effect is attributed to the role of

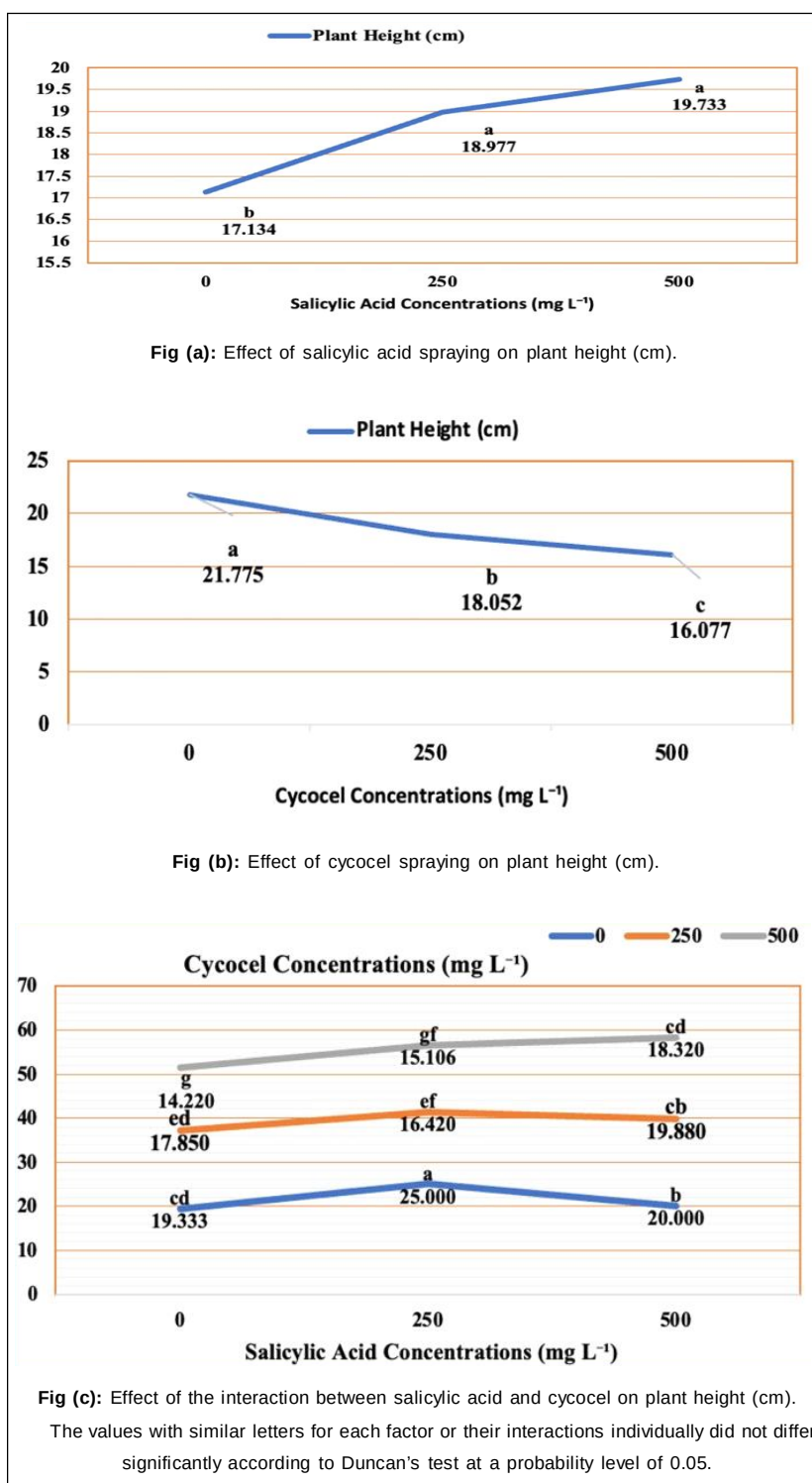


Fig 1: Effect of spraying salicylic acid, cycocel and their interaction on plant height of petunia (*Petunia hybrida* L.).

growth retardants in reducing apical dominance, which stimulates lateral buds and increases the number of lateral branches, thereby enhancing the number of leaves (Soniya *et al.*, 2024). These findings agree with those reported by (Zheng and Xia, 2012), who observed an increase in the

number of leaves of *Lilium* when sprayed with 300 mg L⁻¹ Cycocel. The two-way interaction between the factors, as shown in Fig (2c), had a significant effect on increasing the number of leaves per plant. The highest value of 70.000 leaves per plant was recorded when salicylic acid at

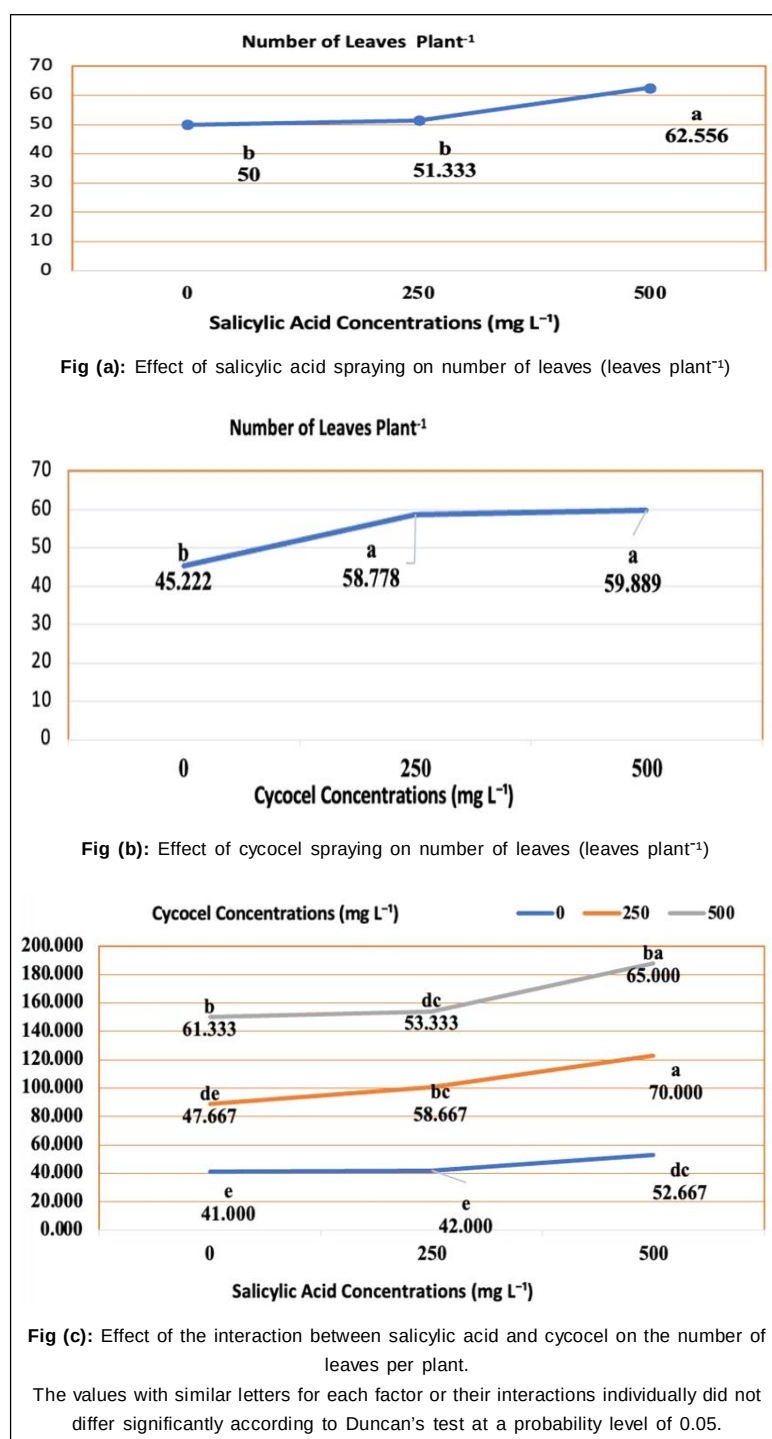


Fig 2: Effect of spraying salicylic acid, cycocel and their interaction on the number of leaves of petunia (*Petunia hybrida* L.).

500 mg L⁻¹ was combined with cycocel at 250 mg L⁻¹. This value was significantly higher than the control treatment for both factors, which recorded 41.000 leaves per plant. This increase can be attributed to the combined effect of salicylic acid in enhancing assimilate production and cycocel in stimulating lateral buds, leading to more branches and consequently a higher number of leaves

(Soniya *et al.*, 2024), This is consistent with what (Qureshi *et al.*, 2018) found when they conducted a study on the plant *Chrysanthemum morifolium* cv. Flirt.

Total leaf chlorophyll content

The data presented in Fig (3a), (3b) and (3c) showed no significant differences among the studied factors in the

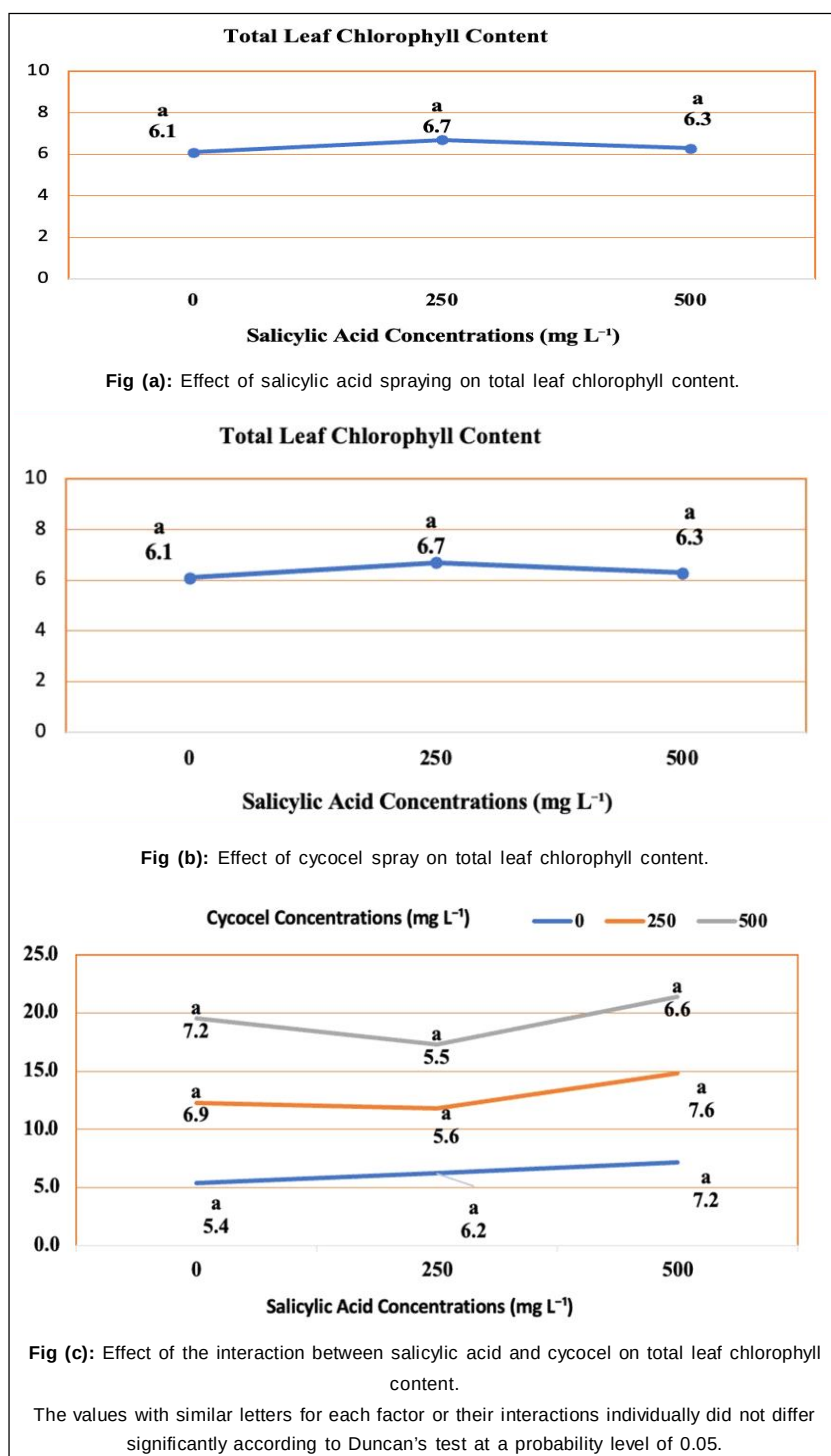


Fig 3: Effect of spraying salicylic acid, cycocel and their interaction on the total leaf chlorophyll content of *Petunia hybrida* L.

trait of total chlorophyll content in the leaves. The lack of significant differences in the effect of salicylic acid on this trait is attributed to the fact that it is more closely linked to regulating physiological responses, reducing oxidative stress and improving the efficiency of the photosynthetic system than to its direct effect in increasing chlorophyll

synthesis. The lack of significant differences in the effect of Cycocel on this trait may also be attributed to its effect mainly in inhibiting the synthesis of gibberellins and reducing vegetative growth rather than its direct effect in the formation of photosynthetic pigments (Cleland and Briggs, 1969; Hayat *et al.*, 2010).

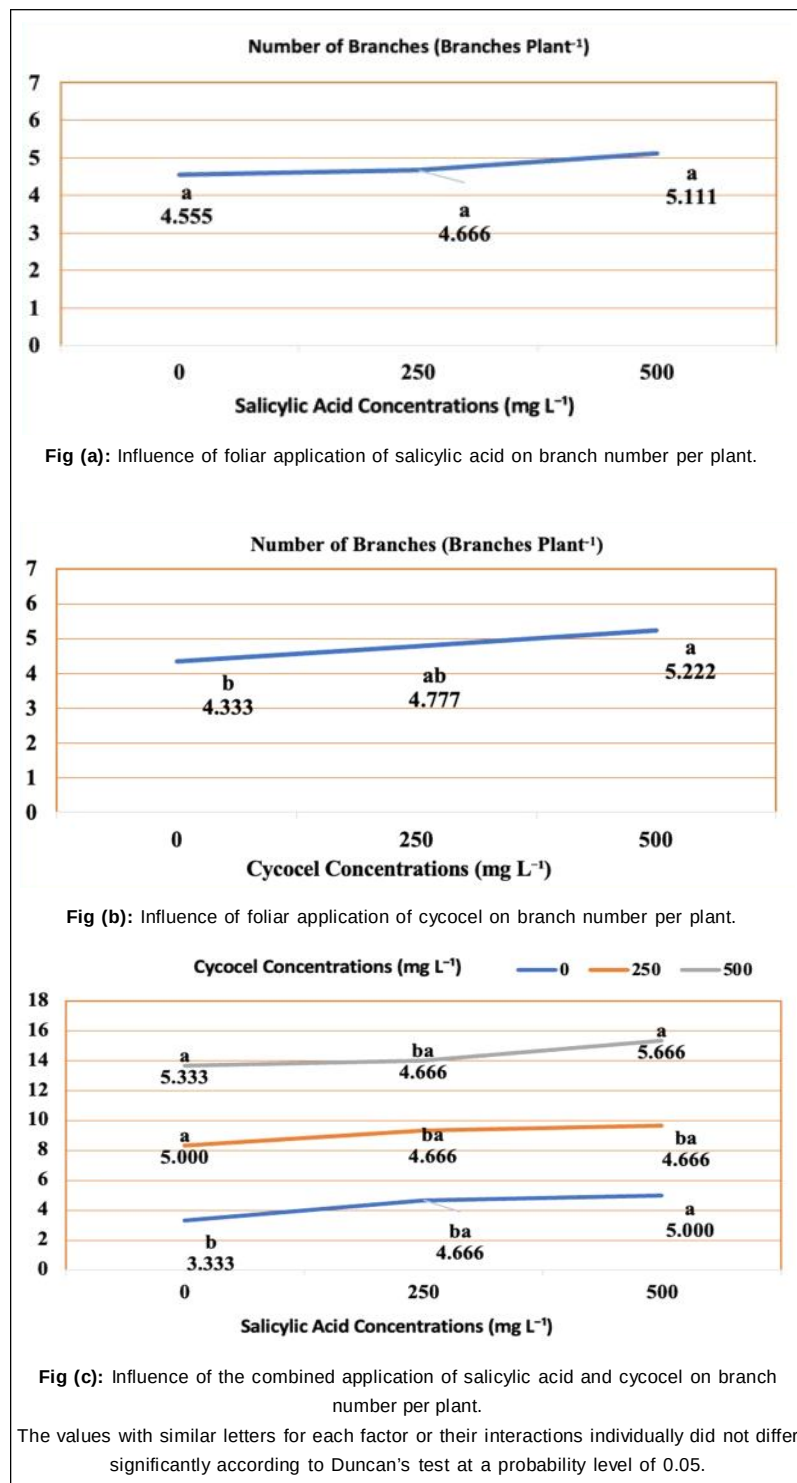


Fig 4: Influence of foliar application of salicylic acid, cycocel and their combined effect on branch number per plant in *Petunia hybrida* L.

Number of branches (branches plant⁻¹)

The data presented in Fig (4a) showed no significant differences in response to salicylic acid spray. However, in Fig (4b), significant differences were observed with cycocel

treatment. Foliar application at a concentration of 500 mg L⁻¹ resulted in the highest branch number, reaching 5.222 branches per plant, compared to the control treatment, which showed the lowest value of 4.333 branches

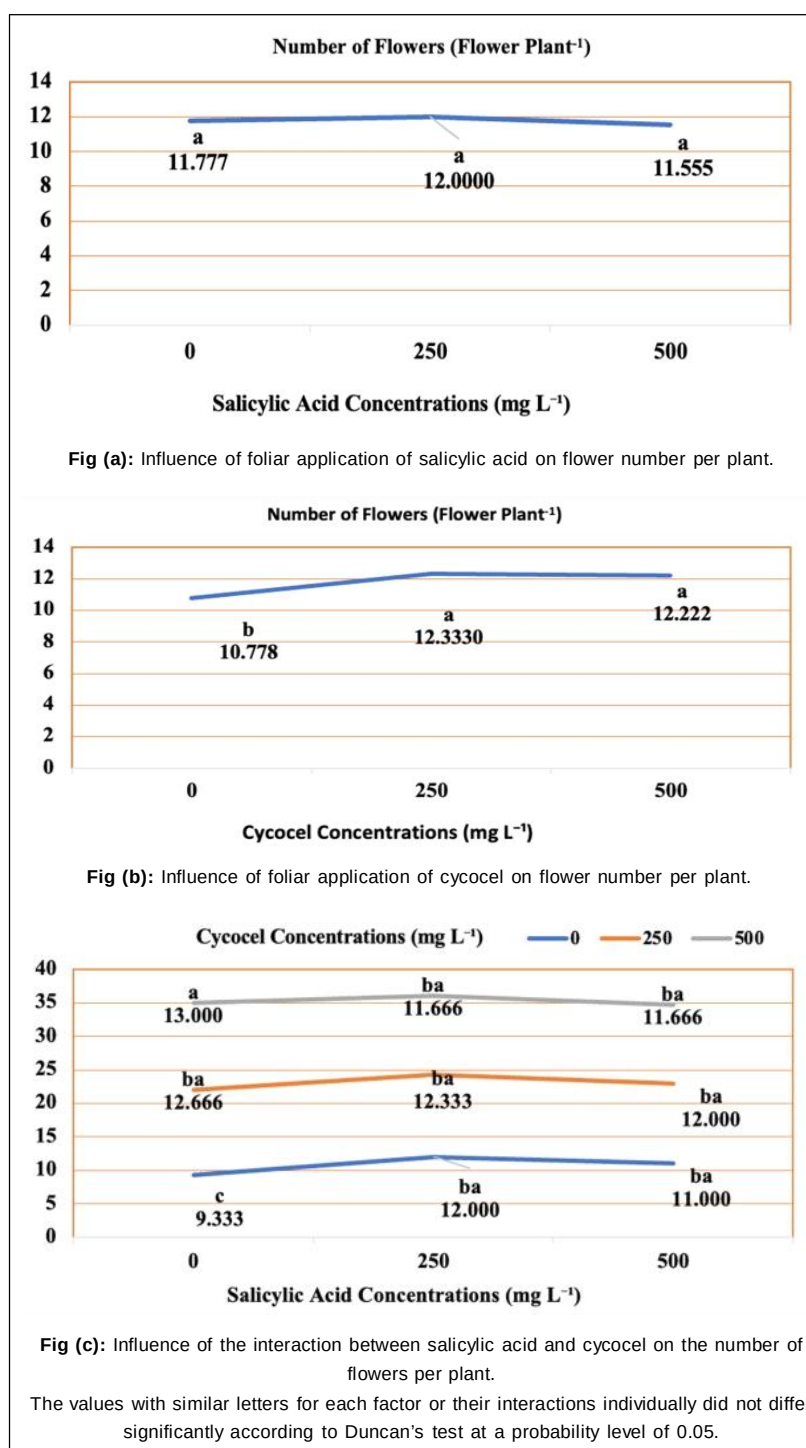


Fig 5: Influence of foliar application of salicylic acid, cycocel and their combined effect on flower number per plant in *Petunia hybrida* L.

per plant. This effect could be attributed to the role of cycocel in overcoming apical dominance, thereby stimulating the growth of lateral buds and promoting branch development (Abdullah *et al.*, 2019). These findings are consistent with those reported by (Kumar *et al.*, 2019) for

cycocel application on *Nerium oleander* and by (Elateeq *et al.*, 2021) on *Chrysanthemum* plants. The two-way interaction depicted in Fig (4c) revealed significant differences among several treatment combinations. This is consistent with the findings of Giri and Beura (2024)

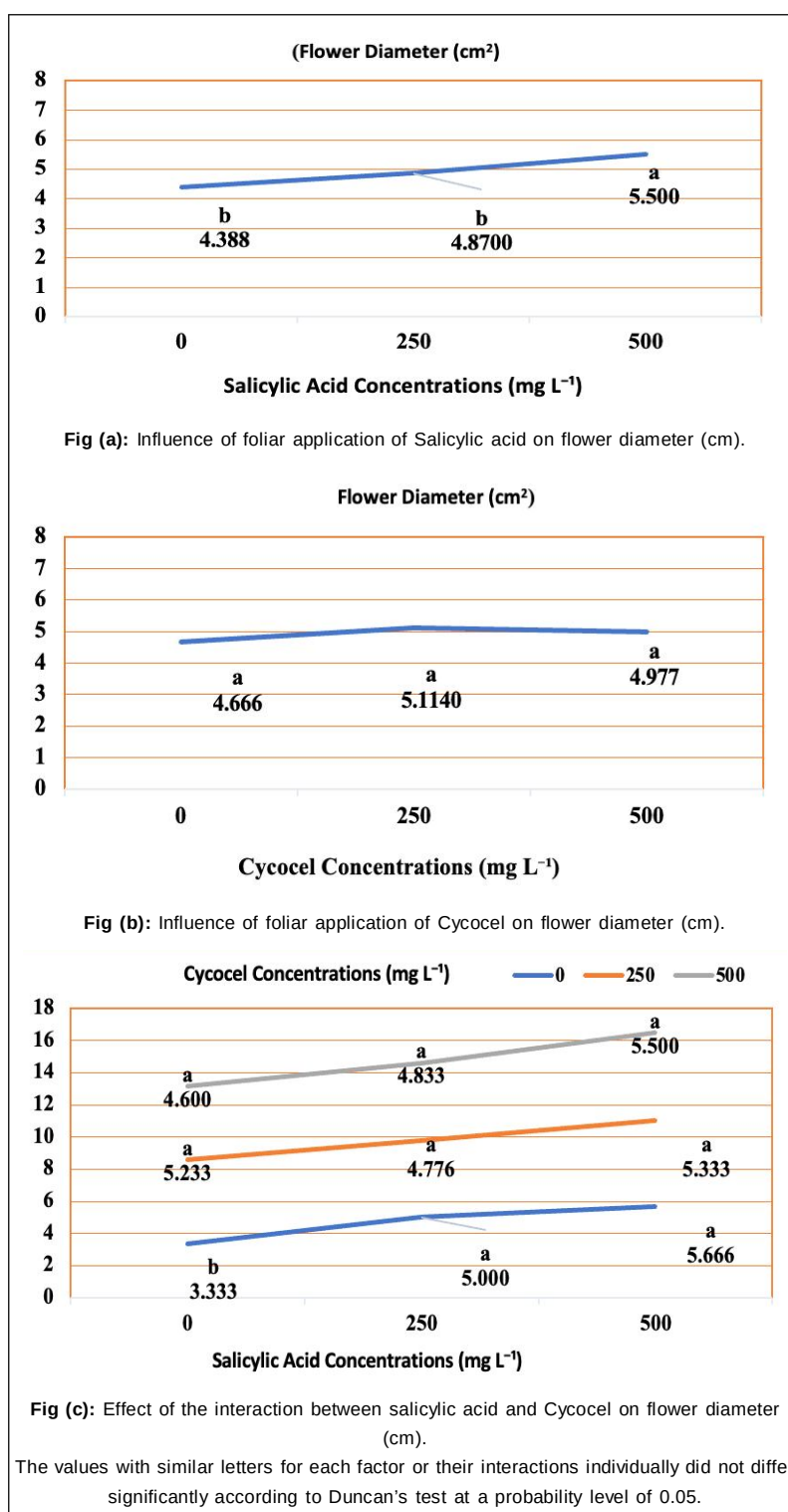


Fig 6: Influence of foliar application of salicylic acid, cycocel and their combined effect on flower diameter in *Petunia hybrida* L.

during their study on the plant (*Gerbera jamesonii* B.) cv. Goliath. The interaction between 500 mg L⁻¹ salicylic acid and the control of the second factor resulted in 5.000 branches per plant. Similarly, the combination of the salicylic acid control and 250 mg L⁻¹ cycocel,

as well as the interaction of 500 mg L⁻¹ salicylic acid with 500 mg L⁻¹ cycocel, produced 5.666 branches per plant. In contrast, the lowest value of 3.333 branches per plant was recorded in the control treatment for both factors.

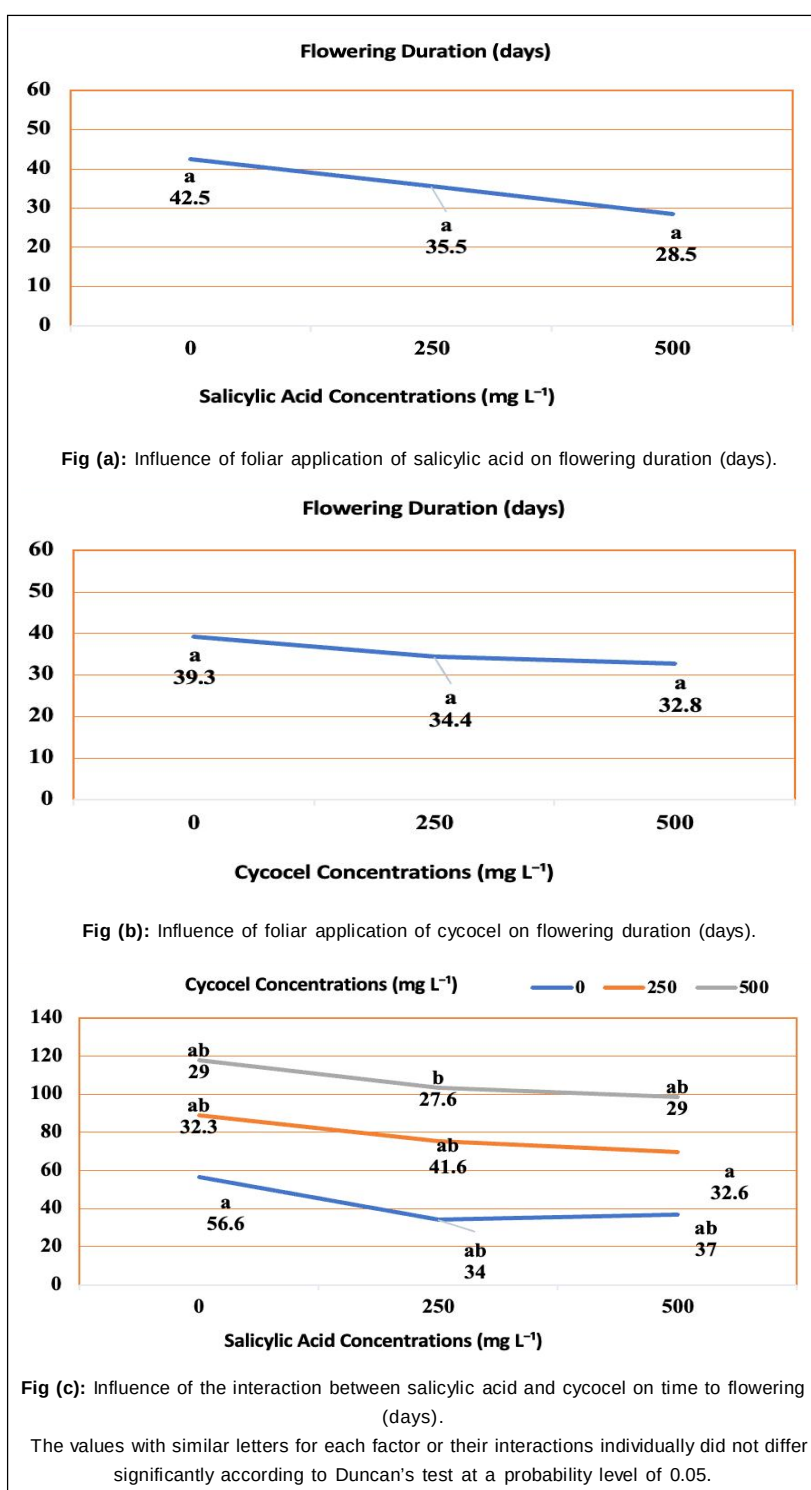


Fig 7: Influence of foliar application of salicylic acid, cycocel and their combined effect on flowering duration (days) in *Petunia hybrida* L.

Number of flowers (flower plant⁻¹)

Fig (5-a) indicates that spraying with Salicylic acid had no significant effect on the number of flowers per plant. In contrast, Fig (5-b) shows significant differences at the

two Cycocel concentrations (250 and 500 mg L⁻¹), where the highest flower numbers were 12.330 and 12.222 flowers per plant, respectively, compared to the control treatment, which recorded 10.778 flowers per plant. This increase

may be attributed to the effect of Cycocel and plant growth regulators such as Paclobutrazol and Alar, which reduce plant height while increasing leaf number and lateral branches. This enhances photosynthetic efficiency, leading to greater carbohydrate accumulation and, consequently, an increased number of flowers (Al-Bayati and Salih, 2021; Soniya *et al.*, 2024; Mahala *et al.*, 2025). These findings are consistent with those reported by (Nariya and Kumari, 2022) in *Chrysanthemum* plants. The two-way interaction shown in Fig (5-c) revealed that the combination of 500 mg L⁻¹ Cycocel with the control treatment of Salicylic acid resulted in the highest flower number, reaching 13.000 flowers per plant. In contrast, the control treatment for both factors produced the lowest number of flowers, 9.333 flowers per plant. This is consistent with (Kikon *et al.*, 2025).

Flower diameter (cm)

The results presented in Fig (6-a) indicate that spraying with Salicylic acid had a significant effect on increasing flower diameter at a concentration of 500 mg L⁻¹, producing the highest value of 5.500 cm, which was significantly higher than the control treatment (4.388 cm). This effect may be attributed to the role of Salicylic acid in enhancing auxin and cytokinin levels, thereby promoting rapid cell elongation. Additionally, it contributes to photosynthetic activity and the provision of nutrients necessary for the formation of new cells, leading to improved vegetative growth, which positively affects flower development. These findings are consistent with those reported by (Nariya and Kumari, 2022) in *Chrysanthemum* plants. In contrast, Fig (6-b) shows that foliar application of the growth regulator Cycocel had no significant effect on flower diameter. The two-way interaction depicted in Fig (6-c) demonstrated a significant increase in flower diameter across all combined treatment concentrations, with values significantly higher than the control treatment for both factors, which recorded the lowest value of 3.333 cm.

Flowering duration (days)

Fig (7-a), (7-b) and (7-c) show that spraying with either factor did not significantly affect the flowering duration. The reason for the lack of significant differences in the rate of the effect of Salicylic acid on the duration of flowering may be attributed to the fact that the physiological effect of this acid focuses on regulating the plant's defensive responses. As for Cycocel, its physiological effect focuses more on inhibiting the biosynthesis of gibberellins, which leads to reduced cell elongation and reduced vegetative growth, rather than its direct effect on the flowering transition. The response of plants to Cycocel also varies depending on the plant type, the concentration used and the stage of growth at the time of addition, which may lead to a clear effect on vegetative characteristics such as plant height and number of branches, without this being significantly reflected on the duration of flowering (Cleland and Briggs, 1969; Hayat *et al.*, 2010).

CONCLUSION

Foliar application of Salicylic acid at concentrations of 0.0, 250 and 500 mg L⁻¹ had a significant effect on most of the studied traits, with varying impacts on vegetative and floral growth traits.

Spraying with the growth regulator Cycocel at concentrations of 0.0, 250 and 500 mg L⁻¹ significantly affected vegetative growth and flowering traits.

The interaction between Salicylic acid and Cycocel sprays had a significant positive effect on improving and enhancing most of the studied vegetative and floral traits.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

Experiment on plants, not animals.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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