Effects of Pinching, Foliar Spraying with Benzyladenine and NPK on Selected Vegetative Growth Characteristics and the Chemical Composition of *Myrtus communis* L. Leaves

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Abstract

The experiment was conducted from 5 May 2025 to 30 Jun 2026 at the Nursery of the Department of Horticulture and Landscape Design, College of Agriculture, Kirkuk University, Iraq. The experiment was designed as a factorial experiment in Randomized Complete Block Design (RCBD) with three replications. The treatments were two pinching levels (non-pinched and pinched), three BA levels (0, 75, and 150 mg L^{-1}), and three NPK fertilizer levels (0, 5, and 10 g L^{-1}). At the end of the experimental period, growth and chemical parameters, including lateral branch diameter, number of lateral branches, total chlorophyll content, and leaf N percentage, were measured. The results showed that all factors significantly affected the traits studied. Vegetative growth was usually better for the pinched plants than for the non-pinched plants. Similarly, branch diameter, number of branches, chlorophyll content, and leaf N concentration were significantly increased with increasing BA concentration and NPK fertilizer level. All evaluated characteristics were highest when the combined effect of pinching, 150 mg L^{-1} BA, and 10 g L^{-1} NPK was used, suggesting a synergistic effect among the treatments. The reasons for these improvements included increased lateral bud development, increased cell division, improved photosynthetic efficiency, and nutrient uptake and utilization. The study shows that pinching combined with foliar application of 150 mg L^{-1} benzyladenine and 10 g L^{-1} NPK is an effective horticultural technique for enhancing vegetative growth and the nutritional quality of the leaves of *Myrtus communis* L. and is highly recommended for commercial nursery production and landscaping.

Keywords: *Myrtus communis* L.; pinching; benzyladenine; NPK fertilizer; vegetative growth

Introduction

Myrtus communis L. A member of the family Myrtaceae, it is one of the oldest aromatic and medicinal evergreen shrubs cultivated all over the Mediterranean basin and Western Asia. The species is widely used as an ornamental, medicinal, pharmaceutical, and industrial plant due to its beautiful leaves, aromatic blooms, edible fruits, and valuable essential oils. Myrtle leaves contain high levels of phenolic compounds, flavonoids, tannins, and volatile oils, including α-pinene, 1,8-cineole, limonene, and myrtenyl acetate, with these compounds exhibiting antioxidant, antimicrobial, anti-inflammatory, and antiseptic properties [1, 2]. *Myrtus communis* L is therefore very popular in public spaces, botanical gardens, medicinal plant collections, and commercial nurseries. Vigor of vegetative growth, dense branching, and dark green leaves, along with high photosynthetic pigment content and mineral nutrient concentrations, are key factors in the commercial value of myrtle. These attributes influence ornamental plantiness, biomass production, and essential oil yield. Environmental conditions and cultural practices, such as pruning, plant growth regulators, and fertilization, significantly

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affect plant growth and chemical composition [3]. Hence, the development of good horticultural practices to modify plant architecture and physiological performance has been an important objective in the production of medicinal and ornamental plants.

Pinching is a horticultural technique that removes the terminal growing point to shift apical growth towards lateral growth, countering apical dominance caused by auxin. This removal decreases auxin levels, enhancing cytokinin activity in lateral buds, which fosters branching and canopy development [3, 4]. Studies indicate that pinching improves branch number, density, leaf area, and ornamental quality, leading to better light interception and biomass production. In aromatic plants, increased branching enhances leaf quantity and essential oil biosynthesis. While known to benefit many crops, there's limited research on its effects on Myrtus communis in Iraqi conditions, particularly in conjunction with growth regulators and mineral fertilization [5].

Benzyladenine (BA), a synthetic cytokinin, is widely utilized in horticulture to enhance cell division, delay aging, boost chlorophyll production, and promote axillary bud development [6]. It regulates various plant physiological processes, including chloroplast differentiation and nutrient mobilization [7,8]. Foliar applications of BA can lead to increased shoot proliferation and nutrient uptake in ornamental and medicinal plants. Additionally, mineral nutrition, particularly through macronutrients nitrogen (N), phosphorus (P), and potassium (K), is crucial for normal plant growth, influencing processes like protein synthesis and photosynthesis [9]. The combination of BA and balanced NPK fertilization may yield synergistic effects, improving growth and photosynthetic efficiency, although research on their interaction in M. communis remains limited [10].

This study investigates the effects of foliar application of benzyladenine and NPK fertilizer, along with pinching, on the vegetative growth and leaf chemical composition of Myrtus communis L. While research on pruning is extensive, there is limited knowledge on the impacts of mineral fertilization and cytokinins in ornamentals, particularly in Iraq. The findings aim to enhance branch diameter, branching, chlorophyll accumulation, nitrogen content, and overall vegetative performance, helping growers optimize cultural practices to improve crop quality and nursery productivity while minimizing excess fertilizer use.

Material and Methods

The experiment was conducted from 5 May 2025 to 30 Jun 2026 at the Nursery of the Department of Horticulture and Landscape Design, College of Agriculture, Kirkuk University, Iraq. One-year-old plants of common myrtle (*Myrtus communis* L.) in uniform, healthy condition were selected for the study. Plants were cultivated in 30-cm-diameter plastic pots containing sandy loam soil (2:1, soil: peat moss). Physical and chemical characteristics of the growth media were analyzed before planting by following standard laboratory methods. To minimize environmental variation between treatments, all plants received the same irrigation, weed control, and pest management throughout the experiment. The experiment was designed as a factorial experiment with three factors and three repetitions, using a Randomized Complete Block Design (RCBD). The experimental units consisted of sets of identical plants.

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The first factor was two pinching treatments:

P1= non-pinched plants (control)

P2= Manually pruned plants that had been cut back after reaching the desired development to encourage lateral branching of the terminal shoot apex.

The second factor was three levels of benzyladenine (BA):

0 mg L^{-1} (Control)

75 mg L^{-1}

150 mg L^{-1}

Benzyladenine solutions were prepared just prior to use by dissolving the desired amount of BA in distilled water, then diluting with a small amount of ethanol. Tween-20 was used as a surfactant to ensure good leaf coverage, and a few drops were added. A hand sprayer was used to spray foliage until runoff in the early morning hours.

The third factor was three rates of NPK fertilizer:

0 g L^{-1} (Control)

5 g L^{-1}

10 g L^{-1}

The water-soluble balanced NPK fertilizer (20-20-20) was dissolved in water and applied along with the other benzyladenine treatments. The foliar applications were made three times over 15 days each during active vegetative growth. Vegetative growth was measured on all plants at the conclusion of the experiment. Using a digital Vernier caliper, the diameter of lateral branches (mm) was measured [11]. For each year, measurements were made at a single spot on typical lateral limbs, before treatment and at the end of the experiment. The difference between the two measurements was the amount of increase in branch diameter [12].

The number of lateral branches was determined by counting all newly developed lateral shoots before treatment and at the end of the experiment. The difference between the end and beginning counts was calculated to determine the increase [13, 14]. Fresh fully expanded leaves from the middle of each plant were used to measure leaf chlorophyll content. Chlorophyll was extracted using 80% acetone, as described by [15]. The absorbance of the extract was spectrophotometrically determined at wavelengths of 645 and 663 nm, and the total chlorophyll content was calculated using the standard equations proposed by Arnon. Data are reported on a fresh weight basis (mg gFW-1). The leaves were dried in an oven at 70°C until constant weight and finely ground. Total Nitrogen percentage was measured by the Micro-Kjeldahl procedure as outlined by [16]. The nitrogen concentration was expressed as a percentage of dry matter.

The collected data were analyzed using Analysis of Variance (ANOVA), which was appropriate for a factorial experiment in a Randomized Complete Block Design (RCBD), conducted in SAS statistical software [17]. Pinching, benzyladenine concentration, and NPK fertilizer levels were tested, and their interaction was studied. Duncan's Multiple Range Test [18] was used to compare treatment means at the 5% significance level ($P \leq 0.05$). The data are shown as treatment means, and different letters denote significant differences between means.

Results and Discussion

The increase in lateral branch diameter in *Myrtus communis* L. plants due to pinching, foliar application of benzyladenine (BA), NPK fertilization,

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and their interaction is shown in Table 1. The highest lateral branch diameter (3.00 mm) was observed in plants that were pinched (P2) and sprayed with 150 mg L^{-1} BA and fertilized with 10 g L^{-1} NPK. In comparison, the lowest lateral branch diameter (1.30 mm) was recorded in the non-pinched plants (P_1) that were not sprayed with BA and did not receive any fertilizer. These results suggest that combining all growth factors resulted in a significant increase in branch thickening. Pinched plants (P_2) had visibly thicker lateral branches than non-pinched plants (P_1), and the main effect of pinching was always significant across all fertilizer levels. The overall mean increase in branch diameter was 2.28 mm for plants that were pinched and 1.80 mm for those that were not. The effect of benzyladenine was found to increase branch diameter in the main effect progressively. Treating plants with 150 mg L^{-1} BA achieved the highest overall mean (2.41 mm), followed by 75 mg L^{-1} (2.00 mm), while the lowest mean (1.72 mm) was observed in untreated plants. In the same way, the branch diameter was greatly improved by a substantial improvement in NPK fertilizer rate. The overall mean for the 10g L^{-1} NPK plant was the highest (2.33 mm), followed by 5g L^{-1} (2.03 mm), and the lowest was obtained from the unfertilized plant (1.76 mm).

The present study revealed that pinching, foliar application of benzyladenine (BA), NPK fertilization, and their combination had significant effects on lateral branch diameter in Myrtus communis. Plants grown with a combination of 150 mg L^{-1} BA and 10 g L^{-1} NPK had the greatest branch diameter, suggesting that this treatment resulted in the most effective vegetative growth. Pinching seems to have a positive effect, primarily by removing apical dominance, thereby reducing auxin production at the shoot apex and promoting lateral bud growth. The process will enhance the distribution of assimilates to developing branches and increase stem thickening and vegetative growth [4]. Pinching has been shown to enhance branching and stem development in many ornamental species.

The addition of benzyladenine also contributed to the increase in branch diameter, as cytokinins promote cell division, vascular tissue development, and chloroplast formation, thereby increasing photosynthetic capacity and branch growth [6]. Furthermore, it provides the necessary macronutrients for protein synthesis, energy metabolism, enzyme activation, and carbohydrate transport. Increased branch diameter is achieved through nitrogen for vegetative growth, phosphorus for energy transfer, cell division, and potassium for photosynthesis and assimilate translocation [9]. The best result observed with the combined treatment indicates a synergistic interaction among pinching, BA, and NPK. Pinching stimulated lateral bud activity and, with NPK, nutrients were provided to support vigorous growth. Shoots grew rapidly when planted with BA, and NPK provided nutrients. This combination of practices therefore resulted in increased thickness of the lateral branches and overall vigor, offering a promising management option for improving the vegetative quality of Myrtus communis.

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Table1:The effect of Pinching, Spraying with Benzyl adenine, NPK and their interaction on the rate of increase in the diameter of lateral branches (mm)

Pinching	BA mL^{-1}	NPK gmL $^{-1}$			P * BA
		0	5	10	
P_1	0	1.30 g	1.70 efg	1.60 efg	1.53 d
	75	1.40 fg	1.70 efg	2.43 bc	1.84 c
	150	1.70 efg	2.03 cde	2.36 bcd	2.03 bc
P_2	0	1.63 efg	1.80 ef	2.30 bcd	1.91 bc
	75	1.90 de	2.26 bcd	2.33 bcd	2.16 b
	150	2.63 ab	2.73 ab	3.00 a	2.78 a
					Pinching effect
P * NPK	P_1	1.46 d	1.81 c	2.13 b	1.80 a
	P_2	2.05 bc	2.26 b	2.54 a	2.28 a
					BA effect
BA * NPK	BA_1	1.46 f	1.75 def	1.95 cde	1.72 c
	BA_2	1.65 ef	1.98 cd	2.38 ab	2.00 b
	BA_3	2.16 bc	2.38 ab	2.68 a	2.41 a
NPK effect		1.76 c	2.03 b	2.33 a	

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Pinching, benzyladenine application, NPK fertilization, and their interaction resulted in a significant increase in the number of lateral branches, as shown in Table 2. Pinched plants with 10 g L^{-1} NPK gave the highest number of newly formed lateral branches (26.00 branches $plant^{-1}$) when treated with 150 mg L^{-1} BA. The lowest value (11.33 branches plant−1) was observed in non-pinched, untreated plants compared with the other varieties. Pinching had a significant effect on branching. The effect of removing apical dominance on branch initiation is supported by the higher mean number of lateral branches in pinched plants (19.81) than in non-pinched plants (16.50). Benzyladenine was also stimulatory to branching. The overall means for the 14.81, 17.88, and 21.77 branches were obtained at BA concentrations of 0%, 150 mg L-1, and 250 mg L-1, respectively. Similarly, branch production was significantly improved by increasing NPK fertilization. Both 10 g L^{-1} and 5 g L^{-1} fertilizer rates had the highest overall mean number of branches (20.27 and 18.65, respectively), whereas unfertilized plants had 15.55 branches. The interaction results showed that lateral branch formation was most strongly stimulated by the combination of pinching and the highest BA concentration, and that NPK levels were highest throughout the experiment.

The results revealed that pinching, foliar application of benzyladenine (BA), NPK fertilization, and their combination had significant effects on the number of lateral branches in Myrtus communis. Pinched plants showed the greatest number of lateral branches (from 150 mg L^{-1} BA and 10 g L^{-1} NPK), and the fewest lateral branches were recorded in untreated, non-pinched plants. The results suggest that a culture-based approach, along with the use of plant growth regulators and balanced fertilizers, could be a good option for achieving desirable shoot proliferation. The formation of additional lateral branches after pinching may correlate with the loss of apical dominance, which allows dormant axillary buds to grow. This allows lateral shoot emergence, resulting in a more compact and highly branched plant architecture [4]. This has been reported in many ornamental plants were pinching results in better branching and plant quality.

Benzyladenine is known for its stimulatory activity, believed to result from its cytokinin-like effects, which stimulate cell division, reactivate axillary buds, and increase shoot initiation. Cytokinins also promote the remobilization of nutrients to growing shoots, thereby promoting more branching and vegetative development [6]. In addition, the beneficial effect of NPK fertilization is attributed to the roles of N, P, and K in photosynthesis, protein synthesis, energy production, and carbohydrate translocation. Good mineral nutrition supplies the materials to produce continuous shoots and branch growth [9]. As the superior treatment, the combination of pinching with BA and NPK appeared to have a synergistic effect in favor of lateral bud activation and the maintenance of high vegetative growth. Hence, these practices may be suggested as a means of achieving well-branched, higher-quality *Myrtus communis* L. plants for ornamental and commercial purposes.

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Table 2: The effect of Pinching, Spraying with Benzyl adenine, NPK, and their interaction on the Mean Increase in the Number of Lateral Branches

Pinching	BA mL^{-1}	NPK gmL^{-1}			P * BA
		0	5	10	
P_1	0	11.33 i	13.25 hi	14.00 ghi	12.86 d
	75	14.33 ghi	17.00 eh	19.00 c-f	16.77 c
	150	15.00 f-i	18.66 c-f	21.66 bcd	19.88 b
P_2	0	13.00 hi	18.00 d-g	19.66 b-e	16.77 c
	75	18.66 c-f	21.66 bcd	23.33 ab	19.00 b
	150	20.00 b-e	22.33 abc	26.00 a	23.66 a
					Pinching effect
P * NPK	P_1	14.55 c	16.75 bc	18.22 b	16.50 a
	P_2	16.55 bc	20.55 a	22.33 a	19.81 a
					BA effect
BA * NPK	BA_1	12.16 f	15.95 de	16.33 de	14.81 c
	BA_2	14.66 ef	18.33 cd	20.66 bc	17.88 b
	BA_3	19.83 bc	21.66 ab	23.83 a	21.77 a
NPK effect		15.55 c	18.65 b	20.27 a	

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The data presented in Table 3 show significant differences among treatments for lateral branch diameter. The largest increase in branch diameter (3.00 mm) was observed in plants that were pinched and treated with 150 mg L^{-1} BA and 10 g L^{-1} NPK, while the lowest value (1.30 mm) was observed in non-pinched, untreated plants. In all fertilizer treatments, the pinched plants had larger-diameter branches than the non-pinched plants, with overall means of 2.28 and 1.80 mm, respectively. Branch thickening was significantly higher at every BA concentration compared to untreated plants, with the highest concentration (150 mg L^{-1}) yielding the greatest mean increase (2.41 mm), followed by 2.00 mm at 75 mg L^{-1} and 1.72 mm in untreated plants. Likewise, branch diameter increased progressively with NPK fertilizer application, with an overall mean diameter of 2.33 mm at 10 g L^{-1} NPK fertilizer compared to 1.76 mm in the unfertilized control. The three experimental factors clearly showed that the highest amount of pinching, combined with the highest concentration of benzyladenine and NPK fertilization, resulted in the greatest increase in lateral branch development.

From the results of this study, it can be concluded that the total chlorophyll content in the leaves was significantly affected by the interaction among pinching, benzyladenine (BA) application, and NPK fertilizer application. Pinched plants fertilized with 150 mg L-1 BA and 10 g L-1 NPK had the highest chlorophyll content, whereas the lowest was observed in the non-pinched, untreated plants. The results suggest that this combination of treatments improved the photosynthetic properties of *Myrtus communis* L. Improved chlorophyll content after pinching may result from improved canopy structure and light penetration, thereby enhancing photosynthetic efficiency and chlorophyll biosynthesis. Moreover, pinching stimulates young growing leaves, which tend to have higher chlorophyll levels than older leaves [3].

The positive response to BA is related to the physiological effects of cytokinins, including the delay of leaf senescence, the stimulation of chloroplast formation, and the synthesis of chlorophyll. In addition, cytokinins are important for retaining chlorophyll stability and consequently enhance photosynthetic activity, thus aiding plant growth [6]. Benzyladenine has been shown to have similar effects on several ornamental and medicinal plant species. The positive contribution of NPK fertilization is primarily that nitrogen is a constituent of chlorophyll, and that phosphorus and potassium are important in energy metabolism, enzyme activation, and nutrient transport. Proper mineral nutrition can thus stimulate chlorophyll formation and photosynthetic activity [9]. The result obtained from the combined treatment showed that the chlorophyll content was greater than in the others, indicating that the three treatments were synergistic, and it can be concluded that the vegetative growth of *Myrtus communis* L was enhanced by increased physiological activity of the leaves.

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Table 3: The effect of Pinching, Spraying with Benzyl adenine, NPK, and their interaction on the Increase in Lateral Branch Diameter (mm)

Pinching	BA mL^{-1}	NPK gmL^{-1}			P * BA
		0	5	10	
P_1	0	1.30 g	1.70 efg	1.60 efg	1.53 d
	75	1.40 fg	1.70 efg	2.43 bc	1.84 c
	150	1.70 efg	2.03 cde	2.36 bcd	2.03 bc
P_2	0	1.63 efg	1.80 ef	2.30 bcd	1.91 bc
	75	1.90 de	2.26 bcd	2.33 bcd	2.16 b
	150	2.63 ab	2.73 ab	3.00 a	2.78 a
					Pinching effect
P * NPK	P_1	1.46 d	1.81 c	2.13 b	1.80 a
	P_2	2.05 bc	2.26 b	2.54 a	2.28 a
					BA effect
BA * NPK	BA_1	1.46 f	1.75 def	1.95 cde	1.72 c
	BA_2	1.65 ef	1.98 cd	2.38 ab	2.00 b
	BA_3	2.16 bc	2.38 ab	2.68 a	2.41 a
NPK effect		1.76 c	2.03 b	2.33 a	

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As shown in Table 4, a significant increase in total leaf chlorophyll content was observed because of pinching, benzyladenine, NPK fertilization, and their interaction. Pinched plants sprayed with 150 mg L-1 BA and fertilized with 10 g L-1 NPK had the highest chlorophyll content (39.83). On the other hand, the lowest chlorophyll values (12.38–12.41) were recorded in the untreated plants, irrespective of the pinching treatment. The main effect of pinching showed that the amount of chlorophyll accumulated in pinched plants was greater than in non-pinched plants, 26.20 compared to 22.65, respectively. The amounts of chlorophylls were greatly stimulated by raising the benzyladenine concentration. The highest mean Chlorophyll content, 30.79, was obtained in plants treated with 150 mg L-1 BA, followed by 24.50 in plants treated with 75 mg L-1 BA, while Chlorophyll in untreated plants was 17.99. Substantial improvement in chlorophyll content was also achieved by NPK fertilization. The highest overall mean (29.97) was observed in plants fertilized with 10 g L^{-1} NPK, followed by 5 g L^{-} 1 NPK (25.67) and unfertilized plants (17.64). The interaction results showed that chlorophyll accumulation increased with increasing concentrations of BA and NPK fertilization, with the most significant increase at the highest concentrations of both, especially with pinching.

The results showed that pinching, foliar fertilization of *Myrtus communis* L, with benzyladenine (BA), NPK fertilization, and their interaction were significant in increasing the percentage of nitrogen in the leaves of Myrtus communis. Pinched plants treated with 150 mg L^{-1} BA and 10 g L^{-1} NPK had the highest nitrogen content, whereas untreated, non-pinched plants had the lowest. Results indicated that these treatments did not have a significant effect on nitrogen uptake and accumulation in plant tissues when used individually; however, when applied together, they resulted in a significant improvement. The effect of leaf nitrogen after pinching could be due to improved vegetative growth and more efficient nutrient utilization in the growth of newly emerged shoots. If the apical bud is removed, lateral growth is stimulated, increasing sink strength and promoting the absorption and use of mineral nutrients, such as nitrogen [3].

Benzyladenine also had a positive effect on leaf nitrogen concentration by promoting leaf cell division, delaying leaf senescence, and mobilizing nutrients towards the growth points. Cytokinins increase the metabolic activity and protein synthesis, leading to higher nitrogen accumulation in plant tissues [6]. Furthermore, BA is associated with active photosynthetic leaves for a longer duration, thus enabling the continued nutrient assimilation. A positive response to NPK application is anticipated because nitrogen is a key component of amino acids, proteins, enzymes, nucleic acids, and chlorophyll. The availability of phosphorus and potassium also helps promote root activity, energy transfer, and nutrient transport, thereby aiding the uptake and use of nitrogen [9]. The highest percentage of nitrogen observed under combined treatment points to a synergistic action of pinching, BA, and balanced fertilization on the plants' acquisition of this element and their overall physiological performance in *Myrtus communis* L.

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Table 4: The effect of Pinching, Spraying with Benzyl adenine, NPK, and their interaction on the Leaf Total Chlorophyll Content

Pinching	BA mL^{-1}	NPK gmL^{-1}			P * BA
		0	5	10	
P_1	0	12.41 ef	17.71 ef	19.34 ef	16.49 d
	75	17.70 ef	24.27 cde	28.24 bcd	23.40 c
	150	18.36 ef	27.87 bcd	37.93 ab	28.05bc
P_2	0	12.38 ef	21.71 bcd	24.35 bcd	19.48 bc
	75	20.11 de	26.56 bcd	30.10 bcd	25.59 b
	150	24.88 ab	35.87 ab	39.83 a	33.53 a
					Pinching effect
P * NPK	P_1	16.16 d	23.28 c	28.50 b	22.65 a
	P_2	19.12 bc	28.05 b	31.43 a	26.20 a
					BA effect
BA * NPK	BA_1	12.40 f	19.71 def	21.85 c-f	17.99 c
	BA_2	18.91 ef	25.42 cd	29.17 ab	24.50 b
	BA_3	21.62 bc	31.87 ab	38.88 a	30.79 a
NPK effect		17.64 c	25.67 b	29.97 a	

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The significantly influenced leaf nitrogen percentage by pinching, benzyladenine treatment, NPK treatment, and their combinations is presented in Table 5. The highest concentration of nitrogen (3.53%) was observed in pinched plants treated with 150 mg L^{-1} BA plus 10 g L^{-1} NPK fertilizer, while the lowest (1.68%) was observed in non-pinched plants without any treatment. Nitrogen accumulation in leaves was significantly greater when pinched. The overall mean nitrogen concentration for the plants that had been pinched was 2.80% compared to 2.64% in the non-pinched plants. The effect of benzyladenine treatment on the nitrogen content was significant. The overall mean N concentrations were highest in the plants treated with 150 and 75 mg L-1 BA (3.21% and 2.76%, respectively) and lowest in the untreated plants (2.21%). A similar trend was observed in leaf N% with increasing NPK fertilizer levels. The overall mean nitrogen concentration was the highest with the highest fertilizer level (10 g L-1) and was significantly lower in plants fertilized at 5 g L-1 (2.77%) and in unfertilized plants (2.36%). Overall, pinching, benzyladenine, and NPK fertilizer consistently resulted in the highest nitrogen accumulation, suggesting that a combination of these treatments was highly effective in improving leaf nutritional status.

This study showed that the percent N in the leaves was significantly influenced by pinching, benzyladenine (BA), NPK fertilization, and their interactions. The highest nitrogen concentration was observed in pinched plants treated with 150 mg L^{-1} BA and 10 g L^{-1} NPK, and the lowest in untreated, non-pinched plants. The results show that the combined application of cultural practices, growth regulators, and balanced fertilization leads to higher leaf nitrogen accumulation in *Myrtus communis* L. The higher leaf nitrogen levels after pinching could be due to stimulation of lateral shoots and the development of new, young, actively growing leaves that serve as strong nutrient sinks. An increase in vegetative growth increases nutrient uptake and translocation, which in turn increases the amount of N accumulating in leaves [3].

The percentage of N in leaves was also increased by application of benzyladenine. BA is a synthetic cytokinin that promotes cell division, delays leaf senescence, and increases the mobilization of nutrients towards the developing tissues. These physiological effects increase plant metabolism and protein production, resulting in more nitrogen remaining in the plant's leaves [6]. In ornamental plants, cytokinin application has been reported to increase nutrient utilization and leaf quality. The positive NPK fertilization effect is mainly linked with the provision of nitrogen, which forms a crucial component of chlorophyll, amino acids, proteins, and nucleic acids. Furthermore, phosphorus stimulates energy transfer and root growth, and potassium stimulates enzyme activity and nutrient transport, thereby increasing nitrogen uptake and the quality of nitrogen assimilation [9]. The synergistic effect of the combined treatment clearly demonstrates the plants' superiority in nutrient status and physiological performance, thereby enhancing their efficiency under stressed conditions.

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Table 5: The effect of Pinching, Spraying with Benzyl adenine, NPK, and their interaction on the Nitrogen Percentage (%) in Leaves

Pinching	BA mL^{-1}	NPK gmL^{-1}			P * BA
		0	5	10	
P_1	0	1.68 g	2.20 f	2.77 de	2.22 d
	75	2.35 ef	2.85 cd	2.97 bcd	2.72 c
	150	2.70 bcd	3.04 bcd	3.23 bc	2.99 bc
P_2	0	1.72 fg	2.09 f	2.79 de	2.20 cd
	75	2.46 e	2.92 bcd	2.99 bcd	2.79 bc
	150	3.26 bc	3.47 ab	3.53 a	3.42 a
					Pinching effect
P * NPK	P_1	2.24 d	2.70 c	2.99 b	2.64 b
	P_2	2.48 cd	2.83 bc	3.10 a	2.80 a
					BA effect
BA * NPK	BA_1	1.70 f	2.15 e	2.78 cd	2.21 c
	BA_2	2.41 de	2.89 bc	2.98 b	2.76 b
	BA_3	2.98 b	3.26 ab	3.38 a	3.21 a
NPK effect		2.36 c	2.77 b	3.05 a	

Conclusion

According to the results of this research showed that both the pinching and the chemical treatment (NPK) and the combination of these two methods have positive effects on vegetative growth and leaf chemical composition of *Myrtus communis* L., since the vegetative growth and branching increased due to the reduction of apical dominance induced by pinching. Similarly, foliar application of BA stimulated vegetative growth by its cytokinin activity, which stimulated cell division, chlorophyll biosynthesis and nutrient mobilization. Additionally, NPK fertilization had a positive effect on plant performance by providing the necessary macronutrients for plant growth and photosynthesis. The highest values for Lateral Branch Diameter, Number of Lateral branches, Total Chlorophyll content, and Leaf Nitrogen percentage were observed in the treatments of pinching and 150 mg L-1 BA and 10 g L-1 NPK, indicating good synergism among these factors across all treatments. The integrated application of culture, plant growth regulators, and balanced mineral nutrition proved more effective than the application of single treatments. The results indicate that this management approach can significantly enhance the ornamental value and vegetative growth of *Myrtus communis* L., with potential applications in commercial nursery production and landscape settings. Other investigations are recommended to assess the long-term effects of these treatments on biomass production, essential oil yield, and accumulation of bioactive compounds under various environmental conditions.

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