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Foliar application of NPK and growth regulators enhances vegetative growth and chemical composition in *Ficus benjamina* L. plants

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Abstract

An experiment was conducted from April 2020 to July 2021 to assess the effects of foliar applications of NPK (0, 0.5, 1, and 2 g/L) alongside two concentrations of GA_3 and BA (150 and 250 ppm) on the vegetative growth and chemical composition of *Ficus benjamina* L. under greenhouse conditions. Results indicated that applying GA_3 or BA with NPK at 1 g/L significantly increased plant height, with GA_3 showing a greater effect on stem diameter than BA. BA promoted branching, and both BA and GA_3 at 250 ppm enhanced root length and the fresh and dry weights of leaves, stems and roots. The lognest roots were observed with NPK at 2 g/L, while NPK at 1 g/L resulted in the heaviest fresh root weight. The maximum content of carbohydrate and nitrogen was obtained with 0.5 g/L NPK and there was relatively greater accumulation of potassium in plant treated with 1 g/L NPK. The GA_3 was more effective than BA in increasing nitrogen and phosphorus content in plants. BA and GA_3 increased chlorophyll-a and -b, with the combination of BA (150 ppm) and NPK (1 g/L) yielding the highest chlorophyll-b levels. The highest carotenoid content was achieved with NPK at 2 g/L combined with either GA_3 or BA. Treatment with BA at 150 ppm enhanced the chlorophyll a/b ratio, while GA_3 at 250 ppm more effectively increased the total chlorophyll-to-carotenoid ratio. These findings suggest that foliar application of NPK at 1 g/L, combined with either BA or GA_3 (250 ppm), optimizes vegetative growth and enhances the chemical composition of *F. benjamina* L. under greenhouse conditions, promoting both growth quality and vigour.

Key words: *Ficus benjamina* L., foliar application, NPK, GA_3, BA, vegetative growth, chemical composition.

Introduction

Ficus benjamina L., a tree in the Moraceae family, is part of a large genus with around 40 genera and 1000 species, including trees, shrubs, lianas, and rare herbs. Known by various names such as Benjamin tree, oval leaf fig, Benjamina fig, and weeping fig, it is native to Asia, Malaysia, Australia, and parts of the Pacific. Widely used as an ornamental and hedge plant, Ficus benjamina is a tropical species and one of the earliest trees cultivated by humans. It is popular as a houseplant, in interiors, landscaping, and outdoor settings (Mahomoodally et al., 2019; Salehi et al., 2020).

Chemical fertilizers for woody plants could be used to improve economic efficiency and benefit the environment through sustainable agriculture (Bai *et al.*, 2020). The positive effect of the fertilization process on the growth of seedlings and trees, for use in various vital activities (Salim *et al.*, 2021) and is an important factor governing the productivity of the trees (Ratana *et al.*, 2019).

The use of NPK fertilizers and growth regulators has been shown to significantly enhance the growth of foliage plants . These substances work synergistically to improve various growth parameters, including plant height, leaf area, root development, and overall biomass (Alavi and Soltani, 2020; Chen *et al.*, 2021; Li and Xu, 2020). The foliar application generally increases the plant height, number of branches per plant, and total number of fruits (Abbas and Ali, 2011). The combination of NPK with specific growth regulators like gibberellic acid (GA_3) and cytokinins has been particularly effective in promoting robust plant growth . This approach not only enhances the physical attributes of the plants but also improves their chemical composition, making them healthier and more resilient Abbas and Ali, 201; Abou El-Ghait *et al.*, 2020).

Plants naturally produce cytokinins to regulate their growth, including cell division, elongation, growth rate, and leaf senescence. There are several commercial plant growth regulators (PGRs) that contain benzyl adenine (BA), a synthetic cytokinin that is more effective than natural cytokinins because it is characterized by a high degree of stability (Al-Maraqi, 2005 and Padhye *et al.*, 2008). Benzyl adenine (BA) compound is most commonly used today for its high efficacy, reliability, and relatively low price (AL-Dalwi and AL-Bakkar, 2022).

Gibberellins (GAs) are a family of plant hormones controlling many aspects of plant growth and development (Abou-El-Ghait *et al.*, 2018). According to Zaghloul *et al.* (2020), the application of GA_3 possesses a highly significant value for the vegetative growth of plants. It has a stimulating impact, is known to be one of the endogenous growth regulators, and could be attributed to its unique roles in plant growth and development, as reported by many researchers. The effect of GA_3 on the growth of various plants has been reported, as GA_3 can modify the growth pattern of treated plants by affecting levels of DNA and RNA, cell division and expansion, biosynthesis of enzymes, protein, carbohydrates, and photosynthetic pigments. Sardoei *et al.* (2014) reported the positive effect of gibberellin on the growth and chemical composition of *Ficus benjamina, Schefflera arboricola,* and *Dizigotheeca elegantissima* plants.

The key objective of the present study was to evaluate the effects of foliar application of NPK, GA_3, and BA on vegetative growth and chemical compositions of *F. benjamina* L. plants under greenhouse conditions.

Materials and methods

A pot greenhouse experiment was conducted during the seasons of 2020/2021 at the Ornamental Horticulture Department Faculty of Agriculture, Cairo University, Egypt to study the response of growth, and chemical composition of *Ficus benjamina* L. plants to foliar applications NPK doses (0.5, 1.0, and 2.0 g/L), GA_3, and BA (each at 150 or 250 ppm) as individual or in combined treatments.

Plant materials and procedure: *Ficus benjamina* L. seedlings (10-11 cm length) were obtained from the Ministry of Agric., Egypt and individually transplanted into plastic pots (30 cm) containing the mixture of clay+ loam soil (1:1V). GA_3 was obtained from Agriculture Research Center. BA was obtained from the Agriculture Research Center.

Treatments: After a month, the seedlings were weekly foliar sprayed (between 09:00 and 11:00 AM) with NPK doses 0.5, 1.0, and 2.0 g/L, GA_3 and BA each at 150 or 250 ppm from ARC. These treatments, besides the control plant, were applied individually or in combination. The soil properties of the potting medium were as follows: pH= 7.8; EC (dS/m) = 1.5; and available N. 45 ppm; available-P 29 ppm; K 1.5 meq/L. The experiment was arranged as factorial, including a Randomized Complete Block Design with 20 treatments (4 NPK doses were the main plots, and 5 treatments of plant growth regulators were set as subplots) with 3 replicates (each replicate contains 2 plants). After 15 months, the different parameters were recorded.

Photosynthetic pigments and total carbohydrates: Chlorophylls (a and b) and carotenoid contents (mg/g FW) were estimated according to Wettstein (1957), then we calculated the ratio between chlo a and b, also the ratio between chlorophylls and carotenoid. The total carbohydrate content was determined in the dried herb sample using the procedure of Dobois *et al.* (1956).

Macro-nutrients: Nitrogen, phosphorus, and potassium contents in plant were determined using the wet digestion procedure (Piper,1947); nitrogen (%) using the Nesslar method (AOCO, 1960), phosphorus (%) according to Snell and Snell (1949) and potassium (%) was determined by using operation chart of Shimadzu Atomic Absorption / Flame Spectrophotometer A646 with a boiling air acetylene burner and recorded read out.

Statistical analysis: The data was subjected to analysis of variance and the means were compared using the least significant difference (LSD) test at the 5% level, as described by Snedecor and Cochran (1980).

Results

Plant height and stem thickness: GA_3 or BA alone treatment increased plant height, whereas the treatment of NPK at 1g/L with the application of GA_3 at 150ppm resulted in the tallest plants (68.16cm), followed by BA at (150ppm) without fertilization (61.89cm) (Table 1). Concerning the effect of GA_3 and BA on stem thickness, spraying with BA was more effective in increasing stem diameter than GA_3 and the control plants. BA at a high level (250 ppm) was more effective in increasing stem thickness than a low level. The interaction effect showed that a high concentration of BA (250 ppm) plus NPK at 2g/L gave the thickest stem (0.84 cm), followed by GA_3 at (250ppm) with NPK at 1g/L.

Table 1. Effect of NPK, GA_3, and BA on plant height (cm) and stem diameter (cm) of *F. benjamina* plants under greenhouse conditions

Treatment	Plant height (cm)					Stem diameter (cm)				
	T0	T5	T6	T7	Mean	T0	T5	T6	T7	Mean
T0	49.75	52.83	49.77	29.83	45.55	0.61	0.64	0.58	0.66	0.62
T1	61.89	56.50	56.33	47.00	55.43	0.75	0.77	0.66	0.76	0.74
T2	51.39	43.67	49.00	47.00	47.77	0.82	0.75	0.82	0.84	0.81
T3	53.16	61.17	68.16	61.00	60.87	0.71	0.60	0.76	0.75	0.71
T4	50.17	45.83	55.5	55.66	51.79	0.65	0.61	0.83	0.79	0.72
Mean	53.27	52.00	55.75	48.10		0.71	0.67	0.73	0.76	
LSD 5%	A	B	AxB			A	B	AxB		
	9.39	3.87	6.30			0.46	0.43	0.70		

T0: control;T1: BA 150 ppm; T2: BA 250ppm; T3: GA_3 150ppm; T4: GA_3 250ppm; T5: NPK 0.5g/L; T6: NPK 1g/L; T7: NPK 2g/L

Number of branches and leaves /plant: Plants with GA_3 or BA resulted in increased branch and leaf formation (Table 2). The application of GA_3 and BA at the high level (250 ppm) was more effective than the low level, whereas GA_3 at 250 ppm gave the greatest number of branches and BA at 250ppm gave the greatest number of leaves. Regarding the interaction effect between fertilizing and PGR the plants treated with BA at 150 ppm without NPK exhibited the greatest number of branches (17.33), followed by the plant sprayed with GA_3 at 250 ppm without NPK (15.67). Plants treated with NPK at 2g/L and BA at 150 ppm showed reduced branch formation. Also, data indicated that spraying BA at 250 ppm with NPK at 1g/L exhibited the greatest number of leaves on the *Ficus* plant (111.30), followed by 1g/L of NPK with GA_3 at a high level (79.97).

Table 2. Effect of NPK, GA_3, and BA on num. of branches and leaves / *F. benjamina* plant under greenhouse conditions

Treatment	Number of branches					Number of leaves				
	T0	T5	T6	T7	Mean	T0	T5	T6	T7	Mean
T0	9.00	10.00	14.00	13.00	11.50	27.53	27.97	39.77	36.20	32.87
T1	17.33	12.30	12.00	9.67	12.80	66.63	73.40	75.43	53.80	67.32
T2	15.00	11.67	13.30	11.67	12.91	59.53	68.00	111.30	72.80	77.91
T3	11.67	15.00	11.00	10.30	12.00	33.03	37.63	38.30	37.87	36.71
T4	15.67	13.00	14.30	12.00	13.74	66.03	52.10	79.97	61.80	64.98
Mean	13.73	12.39	12.92	11.33		50.55	51.82	68.95	52.49	
LSD 5%	A	B	AxB			A	B	AxB		
	5.66	3.40	2.08			15.90	12.44	7.63		

Fresh and dry weights of leaves (g): Data in Table 3 revealed that the heaviest weight was due to the treatment with BA especially 250 ppm which gave (38.40 g). In the case of dry weight, the results showed that BA at a high level (250ppm) increased it (13.85g) compared with the control plant. Regarding the interaction effect, NPK at 1g/L and BA at 250 ppm increased the fresh weight of leaves to the highest value (55.70g), followed by NPK at 1g/L with GA_3 at 250 ppm (40.00 g). The treatment of NPK at 1g/L and BA at 250 ppm was the most effective in increasing the dry weight (18.80 g) followed by NPK at 1g/L with GA_3 at low level (15.70 g).

Root length and root fresh weight: Table 4 revealed that spraying GA_3 or

Table 3. Effect of NPK, GA_3, and BA on fresh and dry weights of leaves (g) of *F. benjamina* plants

Treatment	Fresh weight of leaves (g)					Dry weight of leaves(g)				
	T0	T5	T6	T7	Mean	T0	T5	T6	T7	Mean
T0	12.70	13.40	19.90	18.80	16.20	8.70	6.50	6.60	8.20	7.50
T1	30.70	34.70	37.70	26.30	32.35	10.97	11.80	13.80	10.00	11.64
T2	27.40	32.60	55.70	37.90	38.40	11.10	11.80	18.80	13.70	13.85
T3	15.20	18.10	19.20	19.70	18.05	11.20	9.10	15.70	12.30	12.08
T4	30.40	25.01	40.00	31.34	31.69	12.50	6.13	8.13	8.40	8.79
Mean	23.28	24.76	34.50	26.81		10.90	9.07	12.61	10.52	
LSD 5%	A	B	AxB			A	B	AxB		
	8.85	7.10	4.36			5.17	4.05	2.49		

BA increased the root length compared with control, and the high level (250 ppm) was the most effective. Meanwhile, spraying plants with BA at both levels increased the root's fresh weight than GA_3 and control plants. The Interaction between fertilizing and growth regulator treatments cleared that NPK at 2g/L combined with BA at 250 ppm gave the longer roots (46.00cm), followed by NPK at 2g/L+GA_3 at 250 ppm (44.33cm), then NPK at 2g/L + GA_3 at 250ppm (44.33cm). Treating with NPK at 1g /L + BA at 250 ppm gave roots the heaviest fresh weight.

Table 4. Effect of NPK, GA_3, and BA on root length (cm) and root fresh weight (g) of *F. benjamina* plants

Treatment	Root length (cm)					Root fresh weight (g)				
	T0	T5	T6	T7	Mean	T0	T5	T6	T7	Mean
T0	30.00	18.67	27.00	26.67	25.59	12.86	17.13	16.87	21.45	17.08
T1	32.00	31.30	33.67	27.00	30.99	20.50	26.28	20.14	26.20	23.28
T2	37.30	35.00	40.30	46.00	39.65	22.16	33.60	34.50	19.20	27.37
T3	27.30	31.00	44.30	29.33	32.98	16.30	18.36	16.90	23.84	18.85
T4	34.00	31.67	31.67	44.33	35.42	13.53	21.65	20.00	22.70	19.47
Mean	32.12	29.53	35.39	34.67		17.07	23.40	21.68	22.68	
LSD 5%	A	B	AxB			A	B	AxB		
	9.42	6.01	3.69			9.17	5.29	3.25		

Carbohydrate content in leaves (%DW): Table 5 indicated that treating plants with BA was more effective than GA_3, whereas the high level of BA (250 ppm) gave the high content of carbohydrate (27.55% DW). The treatment of NPK at 0.5g/L +BA on both levels gave the highest content, followed by BA at 150ppm without NPK. Conversely, NPK 2g/L without BA or GA_3 reduced it (22.10%).

Table 5. Effect of NPK, GA_3, and BA on chemical compositions of leaves of *F. benjamina* plants

Treatment	Carbohydrates (% DW)					N (%DW)				
	T0	T5	T6	T7	Mean	T0	T5	T6	T7	Mean
T0	27.00	27.30	27.00	22.10	25.85	1.00	1.30	0.80	0.58	0.92
T1	27.70	27.80	27.30	27.30	27.53	0.40	2.70	0.83	2.40	1.58
T2	27.50	27.80	27.70	27.20	27.55	1.20	1.33	1.20	1.07	1.20
T3	26.00	26.70	25.90	26.30	26.23	1.60	4.70	0.19	0.36	1.71
T4	27.00	27.60	27.70	27.00	27.33	2.72	4.10	1.32	0.13	2.07
Mean	27.04	27.44	27.12	25.98		1.38	2.83	0.87	0.91	
LSD 5%	A	B	AxB			A	B	AxB		
	6.30	3.67	2.25			3.83	2.17	1.33		
Treatment	P (% DW)					K (% DW)				
	T0	T5	T6	T7	Mean	T0	T5	T6	T7	Mean
T0	0.11	0.07	0.11	0.12	0.10	0.80	0.80	1.20	1.00	0.95
T1	0.09	0.07	0.11	0.12	0.10	1.30	1.20	1.20	1.20	1.23
T2	0.09	0.08	0.11	0.12	0.10	1.05	1.15	1.25	1.20	1.16
T3	0.13	0.12	0.14	0.13	0.13	1.15	1.10	1.20	1.10	1.14
T4	0.12	0.12	0.13	0.12	0.12	1.20	1.25	1.15	1.15	1.19
Mean	0.11	0.09	0.12	0.12		1.10	1.10	1.20	1.13	
LSD 5%	A	B	AxB			A	B	AxB		
	0.52	0.32	0.17			1.54	0.88	0.54		

N-content in leaves (%DW): Data in Table 5 indicated that treating plants with GA_3 was more effective than BA in this regard. The highest value (2.07%) was obtained with GA_3 at 250 ppm and the lowest (1.20%) with BA at 250 ppm. Moreover, the treatment of NPK 0.5g/L +GA3 150ppm increased it.

Phosphorus: As shown in Table 5, treating plants with 150 ppm GA_3 increased it to the highest value (0.13%) and BA doses decreased it. Regarding the interaction effect, GA_3 at 150ppm +NPK at 2g/L increased it (0.13%). On the other hand, the two treatments of NPK at 0.5 and 1 g /L +BA at 150ppm gave 0.7%.

Potassium: A marked increase in K% was recorded in plants treated with BA at 150 ppm (1.23%). The interaction effect showed that BA at 150 ppm with no fertilization increased it (1.30%), followed by NPK 1 g + BA at 150ppm and also NPK at 0.5g/L + GA_3 at 250ppm gave the same value (1.25%).

Pigment content: As shown in Table 6, treating plants with BA at 150 ppm increased the Chl content. (a) to 1.23mg/g. Spraying plants with BA (150 ppm) +NPK (1g/L) gave the highest level. In the case of Chl-b, treating plants with GA_3 at 250ppm increased it (2.46mg/g). Moreover, spraying with GA_3 at 250 ppm+ NPK (2g/L) gave the highest level (2.64 mg/g). Also, spraying plants with BA at 150ppm gave the highest content of carotenoids, regarding the ratio between Chl. a/b, treating with BA at 150 ppm increased it to 0.86 and about the interaction effect, spraying plants with low levels of BA+ non-fertilization increased it and plants sprayed NPK without PGR exhibited the lowest ratio (0.42mg/g).

Discussion

The obtained data showed spraying *Ficus benjamina* plants with NPK at 1 g /L resulted in the tallest plants, and 2g/L dose gave the thickest stem. Similar results were reported by EL Sayed *et al.* (2016), who found that NPK at 1 g/ plant gave the highest values of most characters and NPK at 2 g increased stem diameter compared with control in the first and second seasons. Treating plants with GA_3 or BA increased plant and root height reported by Emam (2019), who found that the effect of GA_3+ BA+ NAA in different levels of growth regulators had a beneficial impact on roots, vegetative growth parameters, and chemical constituents of *Chamaedorea seifrizii* plants.

Supplying all NPK doses insignificantly reduced branch formation compared to control. NPK at 1g/L gave the greatest number of leaves /plants, whereas BA positively affected branching. In this regard, Abou-El-Ghait *et al.* (2020) observed that treating *Jasminum sambac* plants with NPK and BA gave the tallest plants, the highest number of branches and leaves, the heaviest leaves fresh weight/plant, the highest number and length of roots/plant, the heaviest fresh weight of roots/plant. The positive effect of BA on branching can

Table 6. Effect of NPK, GA_3, and BA on Chl-a, b, a/b ratio and carotenoid (mg/g FW) of *F. benjamina* leaves

Treatment	Chl-a (mg/g FW)					Chl-b (mg/g FW)				
	T0	T5	T6	T7	Mean	T0	T5	T6	T7	Mean
T0	1.21	1.20	1.16	1.11	1.17	1.16	1.50	1.45	1.78	1.47
T1	1.23	1.23	1.24	1.23	1.23	1.32	1.46	1.69	1.47	1.49
T2	1.19	1.13	1.18	1.24	1.19	1.72	1.94	2.04	2.13	1.96
T3	1.20	1.20	1.18	1.16	1.19	1.55	2.34	2.58	1.97	2.11
T4	1.19	1.23	1.21	1.23	1.22	2.13	2.49	2.57	2.64	2.46
Mean	1.20	1.20	1.19	1.19		1.58	1.95	2.06	2.00	
LSD 5%	A	B	AxB			A	B	AxB		
	1.28	0.74	0.45			1.84	1.44	0.88		
Treatment	Chlorophyl Ratio (a/b)					Carotenoids (mg/g FW)				
	T0	T5	T6	T7	Mean	T0	T5	T6	T7	Mean
T0	0.57	0.48	0.45	0.42	0.48	0.96	0.96	1.16	1.45	1.13
T1	1.06	0.82	0.86	0.69	0.86	1.66	1.44	1.34	1.25	1.42
T2	0.69	0.58	0.58	0.58	0.61	1.19	1.39	1.39	1.35	1.33
T3	0.77	0.51	0.46	0.59	0.58	1.23	1.3	1.25	1.51	1.32
T4	0.90	0.84	0.72	0.84	0.83	1.13	1.36	1.54	1.54	1.39
Mean	0.80	0.65	0.61	0.62		1.23	1.29	1.34	1.42	
LSD 5%	A	B	AxB			A	B	AxB		
	1.50	0.95	0.58			1.64	0.98	0.60		

be attributed to its unique role in plant growth and development, as reported by many researchers.

The growth improvement in the branching of *Ficus benjamina* due to the application of BA can be attributed to its role in stimulating cell division and increased cell number, resulting in increased branch number (Khalighi *et al.*, 2006).

All NPK doses increased the fresh weight of leaves compared with control and NPK at 1g/L gave the heaviest weight. Mohamed *et al.* (2017) reported that all applied treatments of NPK chemical fertilization positively increased all growth parameters such as plant height, number of branches, and fresh and dry weights of basil (*Ocimum basilicum*, L.) cv. Genovese plant.

Spraying *F. benjamina* plants with GA_3 (150ppm) reduced the dry weight of leaves and in contrast to our findings, Zaghloul *et al.* (2020) reported that foliar spray of *Codiaeum Variegatum* with GA_3 resulted in the highest significant values for fresh and dry weights of plant, fresh and dry weights of leaves. Whereas BA 250ppm gave the highest value of it (Emam, 2019).

NPK at 1 g/L and BA at 250 ppm increased the fresh and dry weights. Fertilizing with NPK at 0.5 g/L reduced root length compared to control plants; NPK at 1 g/L increased it, and NPK at 2g increased root fresh weight. Abou-El-Ghait *et al.* (2020) reported similar findings and confirmed that treating plants with NPK and BA gave the heaviest leaves fresh weight/plant, the highest number and length of roots/plant, and the heaviest fresh weight of roots/plant.

Fertilizing the *Ficus* plant with NPK at 0.5 g/L gave the highest carbohydrates and N-contents as well as the treatment of BA 250 ppm only. GA_3 treatments were more effective than BA in increasing the N-content. NPK at 1 and 2 g/L gave the highest P-content and 150 ppm GA_3 also, increased it. A marked increase in K% in leaves was recorded in *Ficus* plants that received NPK at 1g/L. These findings were similar to those reported by Abou-El-Ghait *et al.* (2020), who reported that treating *Jasminum sambac* plants with NPK and BA increased the leaf total carbohydrates content, N, P, and K % by the treatment with BA at 60 ppm + chemical fertilization at 6 g/pot. Also, our findings are in agreement with that reported by Mohamed *et al.* (2017) found that all applied treatments of NPK chemical fertilization positively increased photosynthetic pigments (chlorophyll a, b, and carotenoids), minerals (N, P, and K), and total carbohydrates of basil plant. While Sardoei *et al.* (2014) reported that the application of 200 ppm gibberellic acid+100 ppm benzyl adenine increased the soluble carbohydrate content of *F. benjamina* plants to 36.09% compared to the control treatment.

The results of our study indicated that the Chl-a content was the same in plants treated with either NPK at 1 or 2g/L plus BA at 150 ppm, and these treatments increased it. Similar results were stated by Mohamed *et al.* (2017) and Abou-El-Ghait *et al.* (2020).

Spraying *Ficus* plants with GA_3 at 250 ppm was more effective than BA in increasing P, K, Chl-b, and total Chl (A+B) contents. The ratio between total Chl/Carotenoids, similar results were reported by Ashour *et al.* (2020), who stated that combined NPK with either BA or GA_3 significantly increased most of the biochemical contents over the control plants. It is interesting that GA_3 was more effective than BA when combined with NPK.

From our results, the foliar application of NPK at 1g/L can be recommended to improve the growth and quality of *Ficus benjamina*. The high level of BA (250ppm) was the most effective for increasing quality, vegetative growth, and chemical composition. Spraying with GA_3 at 200 ppm was more effective than BA in increasing the ratio between total Chlorophyl/ Carotenoids The treatments of BA at 250ppm + NPK at 2g/L and 1 g/L greatly improved stem thickness and formation of leaves, respectively.

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References

Abbas, M.K. and A.S. Ali, 2011. Effect of foliar application of NPK on some growth characters of two cultivars of Roselle (*Hibiscus sabdariffa* L.). *Am. J. Plant Physiol.*, 6(4): 220-227.

Abou, El-Ghait E.M., A.S.M. Youssef, Y.F.Y. Mohamed, T.M. Noor El-Deen and H.I. Mohamed, 2020. Effect of benzyladenine and chemical fertilization on growth, flowering, and chemical composition of *Jasminum sambac* plant. *Sci. J. Flowers Ornamental Plants*, 7(4): 379-391.

Abou,-El-Ghait E.M., A.O. Gomaa, A.S.M. Youssef and A.M. EL-Nemr, 2018. Effect of kinetin and GA3 treatments on growth and flowering of *Dendranthema grandiflorium* cv. Art Queen plants. *Middle East J. Agric. Res.*, 7(3): 801-815.

AL-Dalwi, L.M.S. and A.H.A.-Q. AL-Bakkar, 2022. Effect of benzyl adenine on the vegetative and root growth of seedlings of *Myrtus communis* L. *Br. J. Glob. Ecol. Sustain. Dev.*, 7: 2754-9291.

Al-Maraqi, A.J.M, 2005. *Chemistry of Horticultural Plants*. Alexandria University Press - Arab Republic of Egypt.

Alavi, S. M., and H. Soltani, 2020. Response of *Dianthus chinensis* to different levels of nitrogen fertilization. *J. Plant Nutr.*, 43(7): 1023-1034. https://doi.org/10.1080/01904167.2020.1714567.

Ashour, HA, A.B. El-Attar and M.M. Abdel Wahab, 2020. Combined effects of NPK fertilizer with foliar application of benzyl adenine or gibberellic acid on *Dracaena marginata* 'Bicolor' grown in different potting media. *Ornam. Hortic.*, 26(4): 545-561.

AOAC 1984. Association of Official Analytical Chemists: Arlington, VA, 1984.

Bai, Y.C., Y.Y. Chang, M. Hussain, B. Lu, J.P. Zhang, X.B. Song, X.S. Lei and D. Pei, 2020. Soil chemical and microbiological properties are changed by long-term chemical fertilizers that limit ecosystem functioning. *Microorganisms*, 8(5): 694.

Chen, Y., X. Zhao, and W. Liu, 2021. Effect of phosphorus and potassium fertilization on the growth and flowering of Chinese carnation. *Hortic. Sci.*, 56(4): 178-185. https://doi.org/10.17221/95/2021-HORTSCI.

Dobois, M., K.A. Gilles, J.K. Hamilton, P.A. Rebers and F. Smith. 1956. Colorimetric methods for determination of sugar and related substances. *Anal. Chem.*, 28(3): 350-356.

El-Sayed, B.A., T.M. Noor El-Deen, L.M. Abdel-Galeil and M.A. El-Ashwah, 2016. Effect of NPK and gibberellic acid on growth and quality of *Cycas revoluta* "Thunb." *Sci. J. Flowers Ornamental Plants*, 3(1): 87-94.

Emam, ONK, 2019. Usage of actosol (humic acid) and some growth regulators for improving plant quality of *Chamaedorea seifrizii, burret*. *Sci. J. Flowers Ornamental Plants*, 6(3): 175-189.

Jarecki, W., J. Buczek and D. Bobrecka-Jamro, 2017. Response of spring wheat to different soil and foliar fertilization. *J. Cent. Eur. Agric.*, 18(2): 460-476.

Khalighi, A., Y. Hojati, M. Babalar and R. Naderi, 2005. Effects on nutrition solutions, cytokine, and soil texture on bulb growth, quality of bulb, and number of bulblet in Drawin hybrid tulip Apeldoorn. *J. Pajoush Sazandegi*, 73: 58-64.

Li, H., and Q. Xu, 2020. Influence of high nitrogen fertilization on the vegetative growth and flower production of Chinese carnation. *Plant Soil*, 448(1-2): 123-135. https://doi.org/10.1007/s11104-020-04445-3.

Mahomoodally, M.F., F. Asif, R. Rahman and A.I.S. Nisar, 2019. A review of the pharmacological potential and phytochemical profile of Weeping Fig-*Ficus benjamina* L. *Int. J. Chem. Biochem. Sci.*, 16: 70-75.

Mohamed, S.M., EM Abou El-Ghait, Y.F.Y. Mohamed and E.G.M. El-Sabagh, 2017. Integrated management of fertilizer (NPK, chicken manure and yeast) to improve the growth, oil productivity, and volatile oil constituents of *Ocimum basilicum* L. var Genoves plant. *Middle East J. Agric. Res.*, 6(4): 1155-1170.

Padhye, S., E. Runkle, M. Olrich and L. Reinbold, 2008. Improving branching and postharvest quality. *Greenhouse Prod.*, 8(8).

Piper ,C.S. 1947. *Soil Plant Analysis.* The Univ. of Adelaide, Adelaide, p. 258–275.

Ratana, S. Mishra and V. Bahadur, 2019. Effect of chemical fertilizers, bio-fertilizers, and organic manure on growth, yield, and quality of guava under Prayagraj agro-climatic condition. *J. Pharmacogn. Phytochem.*, 8(4): 3154-3158.

Salehi, B., A.P. Mishra, M. Nigam, N. Karazhan, I. Shukla, A. Kiełtyka-Dadasiewicz, B. Sawicka, A. Głowacka, M.S. Abu-Darwish, A.H. Tarawneh, A.V. Gadetskaya, C. Cabral, L. Salgueiro, M. Victoriano, M. Martorell, A.O. Docea, A. Abdolshahi, D. Calina and J. Sharifi-Rad, 2020. *Ficus* plants: State of the art from a phytochemical, pharmacological, and toxicological perspective. *Phytother. Res.*, 35(3): 1187-1217.

Salim, N.S., N.A. Abid and Y.M. Saleh, 2021. Effect of some macro elements Ca, N, P, K on the quantitative and qualitative characteristics of the fruit. A Review. *Tex. J. Multidiscip. Stud.*, 3: 271-275.

Sardoei, A.S., F. Shahadadi, M. Shahdadneghad and T. Sadeghi, 2014. Positive effect of growth regulators on the soluble carbohydrates of *Ficus benjamina, Schefflera arboricola* and *Dizigotheeca elegantissima* plants. *Int. J. Biosci. (IJB)*, 4(10): 263-268.

Snell, F.D. and C.T. Snell. 1949. *Colorimetric Methods Anal.* 3rd ed. Van Nostrand, New York, USA, pp. 785–807.

Wettstein, D. 1957. Chlorophyll lethol und dres sunbmikr Skopiscke formivechsel der plastiden. *Exp. Cell Res.*, 12: 427.

Wu, T., Z. Wang, and L. Jiang, 2019. Impact of different NPK ratios on the flowering and chlorophyll content of *Dianthus chinensis*. *J. Hortic. For.*, 11(3): 45-53. https://doi.org/10.5897/JHF2019.0567.

Zaghloul, M., Y.M. Abd El-Fattah, M.M. Khedr and M.A. Elsadek, 2020. Effect of Different Ratios Nano-Fertilizer and Gibberellic Acid on the Vegetative Growth and Chemical Compositions of *Codiaeum variegatum* (L.) cv. Gold Dust. *Hortscience J. Suez Canal Univ.*, 9(1): 31-44.

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