Tikrit Journal for Agricultural Sciences
ISSN:1813-1646 (Print); 2664-0597 (Online)
Journal Homepage: http://www.tjas.org
E-mail: tjas@tu.edu.iq

TJAS
Tikrit Journal for Agricultural Sciences

DOI: https://doi.org/10.25130/tjas.26.2.12

Chemical components of Brown Turkey fig leaves affected by spraying with benzyl adenine and nano-calcium

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KEY WORDS:
benzyl adenine, nano calcium, Brown Turkey, figs, leaf constituent

Received: 18/03/2025
Revision: 10/09/2025
Proofreading: 18/11/2025
Accepted: 21/09/2025
Available online: 30/06/2026

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ABSTRACT

An experiment was conducted in the fields of the Department of Horticulture and Landscape / College of Agriculture / Tikrit University during 2024 growing season, to determine the effect of foliar spraying with benzyl adenine and nano calcium on some chemical properties of fig leaves, Brown Turkey cultivar. The trees were sprayed three times during the growing season with three concentrations of benzyl adenine (0, 75 and 150 mg L^{-1}) and nano calcium oxide (0, 1.25 and 2.50 g L^{-1}). The treatments arranged Randomized Complete Block Design (RCBD) with three replicates and one tree as experimental unit. The results indicated that the spraying with benzyl adenine at 150 mg L^{-1} affected significantly and recorded the highest average of nitrogen (2.24%), calcium (1.466%), total chlorophyll and carotenoids (128.89 and 0.514 mg 100 g^{-1} fresh weight respectively) and lowest average of carbohydrate: nitrogen ratio (7.14) in fig leaf comparison control treatment that recorded 1.73%, 1.14%, 119.78 mg 100g^{-1}, 0.227 mg 100 g^{-1} and 8.866 for previous characteristics respectively. Nano-calcium also affected significantly, it's high concentration (2.5 g L^{-1}) raised the leaf content of nitrogen (2.16%), calcium (1.425%), total chlorophyll and carotenoids (127.67 and 0.427 mg 100 g^{-1} fresh weight) comparison to the control treatment that recorded a lowest average of nitrogen, calcium, total chlorophyll and carotenoids which were 1.88%, 1.137%, 120.00 and 0.319 mg 100 g^{-1} fresh weight for previous characteristics. These results reflected to effectiveness of interaction treatments, that the interaction treatment between the height concentration of benzyl adenine and nano-calcium was a best treatment and recommended.

المكونات الكيميائية لأوراق التين صنف Brown Turkey بتأثير الرش بالبنزل أدينين والكالسيوم النانوي

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الخلاصة

أُجريت تجربة في حقول قسم البستنة وهندسة الحدائق / كلية الزراعة / جامعة تكريت خلال موسم 2024 لدراسة تأثير الرش الورقي بالبنزل أدنين والكالسيوم النانوي في بعض الخصائص الكيميائية لأوراق التين صنف Brown Turkey. وقد رشت الأشجار ثلاث مرات خلال الموسم، بثلاثة تراكيز من البنزل أدنين (0، 75، 150 ملغم لتر$^{-1}$) وثلاثة تراكيز من أوكسيد الكالسيوم النانوي (0، 1.25، 2.50 غم لتر$^{-1}$). نفذت التجربة وفق تصميم القطاعات العشوائية الكاملة بثلاثة مكررات وشجرة واحدة في الوحدة التجريبية، أشارت النتائج إلى أن تأثير الرش بالبنزل أدنين كان معنوياً في معظم الصفات المدروسة، وسجل التركيز 150 ملغم لتر$^{-1}$ أعلى متوسط لمحتوى الأوراق من النتروجين (2.24%)، الكالسيوم (1.466%)، الكلوروفيل الكلي والكاروتينات (128.89 و 0.514 ملغم 100 غم$^{-1}$ وزن طري بالتتابع)، وسجلت اقل قيمة لنسبة الكربوهيدرات: النتروجين (7.14) مقارنة بما سجلته معاملة المقارنة للصفات المذكورة والتي كانت 1.73%، 1.114%، 119.78 و 0.227 ملغم 100 غم$^{-1}$ وزن طري و8.66 على التوالي. كما ان الرش بالكالسيوم النانوي أثر معنويا فزاد محتوى الأوراق من النتروجين (2.16%) والكالسيوم (1.425%) والكلوروفيل الكلي والكاروتينات (127.67 و 0.427 ملغم غم$^{-1}$ وزن طري) بالمقارنة مع معاملة عدم الرش التي سجلت اقل القيم لتلك الصفات فبلغت 1.88%، 1.137%، 120.00 و 0.319 ملغم 100 غم$^{-1}$ وزن طري على التوالي. وان تلك النتائج انعكست على تأثير معاملات التداخل إذ اعطت معاملة تداخل المستوى العالي لكل من البنزل ادينين والكالسيوم النانوي أفضل النتائج فكانت المعاملة التي يوصى بها لتحسين الصفات الكيميائية لأوراق أشجار التين صنف Brown Turkey.

الكلمات المفتاحية: حمض البنزل أدنين، الكالسيوم النانوي، التين، براون تركي، الصفات الكيميائية للأوراق.

INTROUCTION

Figs (*Ficus carica* L.) belong to the Moraceae family which contains more than 2000 species of trees and shrubs and the genus Ficus includes about more than 800 species, most of them are evergreen and a limited number of these trees have edible fruits and the majority of them are classified as ornamental plants (Harrison, 2005 and Herre et al., 2008). Many researches and studies have proven that plant growth regulators not only in increasing vegetative growth, but also their clear effect in increasing nutrient absorption and improving quality traits. Benzyl adenine is a cytokinins, which are hormonal growth-regulating substances that affect the growth and development of the plant, as they help in cell division and development. It is one of the most widely used industrial growth regulators due to its high stability and relatively cheap price (Al-Khafaji, 2014). Al-Dulaimi (2015) found that spraying fig saplings of Aswad cultivar with CPPU growth regulator (Cytokinin) at 10 mg L^{-1} led to a significant increment leaf content of N (1.44%), P (0.22%), K (1%), carbohydrate (17.47%) and chlorophyll pigment (54.46 mg g^{-1}) compare to control treatment. The spray apricot trees with Sitofex cytokinin (15 mg L^{-1}) raised the total chlorophyll in leaf statistically (Medan and Al-Douri, 2021).

Calcium one of the essential nutrients for higher plants. It has many vital functions and is a key element in the primary cell wall structure and it save the permeability of cellular membranes which it be leaky in the absence calcium (Pilbeam and Morly, 2007). Although calcium is available in most soils, providing it to plant during the critical stage is beneficial for improving growth and production. Recently, the use of nano-fertilizers has become common due to it can provide nutrients to plants or help increase the effectiveness of conventional fertilizers because of its small particles and large surface area (Das et al., 2004, DeRosa et al., 2010). Al-Janabi et al. (2021) reported that the

foliar spray of pomegranate transplants with nano-calcium raised the concentration of nitrogen and calcium in leaf significantly. Alawadi (2020) recorded a significant increase in a chlorophyll pigment of fig leaf. Due to the lack of studies in the Salah Adden province on the Brown Turkey fig cultivar, this study was conducted to determine the effect of spraying with benzyl adenine and nano calcium on the chemical components of fig tree leaves.

MATERIAL AND METHODS

The experiment was conducted in the fields of the Department of Horticulture and Landscape/ College of Agriculture / Tikrit University during 2024 growing season, to investigate the effect of foliar spraying with benzyl adenine and nano calcium on leaves chemical characteristics of Brown Turkey fig trees. The trees were planted on 2× 3 m apart, in clay loam soil of pH= 7.41, EC= 4.84 ds m^{-1} and watered with drip irrigation system. The experiment included two factors, the first is benzyl adenine growth regulator at three concentrations (0, 75 and 150 mg L^{-1}), and the second factor is nano-calcium oxide at three concentrations (0. 1.25 and 2.5 g L^{-1}). The foliar spray was done three times in the growing season at 15 days interval; the first one was on 4th of April 2024 when the new shoots arrived to 15 cm along. The nine treatments were arranged in Randomized Complete Block Design (RCBD) with three replicates and one tree in an experimental unit. The collected data was statistically analyzed with SAS application and means were compared according to Duncan's Multiple Test at 0.05 probability (Al-Rawi and Khalaf Allah, 2000).

Studied characteristics: leaf samples were taken in mid-August, from every fig tree (experimental unit), dried, digested and analyzed chemically to determine the chemical components. The **nitrogen** percent (N%) was determined by Micro Kildahl device according to Page et al. (1982). **Calcium** (Ca%) in leaves was measured using Flame photometer according to the method of Al-Domi et al., (1996). Total **chlorophyll and carotenoids** were measured spectrophotometrically according to Lichtenthaler and Wellburn (1985). Finally, the **carbohydrate** (%) was extracted and determined in a dried leaf sample by a spectrophotometer at 490 nm wave length according to Joslyn (1970).

RESULTS AND DISSCUSION

Nitrogen (%): Foliar spraying fig trees of benzyl adenine resulted in a significant increase in nitrogen content in the leaves (Table 1). The leaves of trees were treated with a high concentration of benzyl adenine had the greatest nitrogen content (224%), compared to the low-level benzyl adenine and comparison treatments, which produced the lowest result (1.73%). Nano-calcium foliar spraying improved the nitrogen content of fig leaves. The two levels of nano-calcium increased a nitrogen value and exceeded the control treatment, when they gave 2.01% and 2.16% of nitrogen respectively. Regarded to interaction treatments, all these surpassed the control treatment significantly. The nitrogen content in fig leaves was highest (2.31%) in the treatment interaction between the higher level of benzyl adenine and nano-calcium (B_2C_2), compared to the lowest value (1.55%) of the control treatment (B_0C_0).

Table 1: Effect of foliar spraying with benzyl adenine, nano calcium and their interaction on Nitrogen percent in leaves

benzyl adenine	Nano calcium			Average benzyl adenine
	C_0	C_1	C_2	
B_0	1.55 i	1.69 h	1.94 f	1.73 c
B_1	1.91 g	2.09 e	2.23 c	2.08 b
B_2	2.17 d	2.24 b	2.31 a	2.24 a
Average nano calcium	1.88 c	2.01 b	2.16 a	

Averages with similar letters do not have a significant difference according to Duncan's test at a 5% probability level.

Calcium (%): It is noted from the results in table (2) that the leaf calcium percent increased with increasing levels of benzyl adenine spraying solution with an average of 1.271 and 1.466% for 75 and 150 mg L^{-1} of benzyl adenine respectively, meanwhile the control treatment recorded the lowest average of 1.114%. While non-treated trees had the lowest average of 1.137%, the calcium percentage in fig leaves likewise rose as the concentration of spraying solution nano-calcium increased, averaging 1.288 and 1.425% at levels 1.25 and 2.50 g L^{-1}, respectively. The interaction treatments recorded a significant difference between them. The treatment C_2B_2 gave the highest percent of calcium reaching 1.623%, while the control treatment recorded the lowest one, reaching 1.000%.

Table 2: Effect of foliar spraying with benzyl adenine, nano calcium and their interaction on calcium percent in leaves

benzyl adenine	Nano calcium			Average benzyl adenine
	C_0	C_1	C_2	
B_0	1.000 h	1.120 g	1.223 f	1.114 c
B_1	1.120 g	1.263 e	1.430 c	1.271 b
B_2	1.293 d	1.483 b	1.623 a	1.466 a
Average nano calcium	1.137 c	1.288 b	1.425 a	

Averages with similar letters do not have a significant difference according to Duncan's test at a 5% probability level.

The results of table (3) showed that spraying with benzyl adenine led to a significant increase in the chlorophyll content of the leaves, as the two concentration (75 and 150 mg L^{-1}) gave an average 125.22 and 128.89 mg 100 g^{-1} respectively, and significantly surpassed the control treatment that recorded 119.78 mg 100 g^{-1} of total chlorophyll. The two treatments of nano-calcium spraying (1.25 and 2.5 g L^{-1}) were similar in their effect, as they increased the chlorophyll content of the leaves and significantly outperformed the comparison treatment, with values reaching 126.22, 127.67 and 120 mg 100g^{-1} fresh weight for the three treatments, respectively. The interaction treatments between benzyl adenine and nano-calcium showed clear significant differences between most of the treatments, as the C_1B_2 treatment recorded the highest chlorophyll content of 132.67 mg 100 g^{-1} and surpassed all interaction treatments, while the control treatment gave the lowest value of 116.00 mg 100 g^{-1} fresh weight of fig leaves.

Table 3: Effect of foliar spraying with benzyl adenine, nano calcium and their interaction on total chlorophyll in fig leaves (mg 100 g^{-1})

benzyl adenine	Nano calcium			Average benzyl adenine
	C_0	C_1	C_2	
B_0	116.00 h	119.00 g	124.33 d	119.78 c
B_1	121.67 f	127.00 c	127.00 c	125.22 b
B_2	122.33 e	132.67 a	131.67 b	128.89 a
Average nano calcium	120.00 b	126.22 a	127.67 a	

Averages with similar letters do not have a significant difference according to Duncan's test at a 5% probability level.

The results of table (4) indicated that the leaf content of total carotenoids increased statistically with increasing benzyl adenine concentration in foliar solution. The carotenoids in leaf were 0.374 and 0.514 mg 100 g^{-1} for the two levels of benzyl adenine (75 and 150 mg L^{-1}) respectively. Whereas the control treatment recorded 0.227 mg 100 g^{-1}. Spraying with nano calcium led to a significant increase in the leaf content of carotenoids, as the levels 1.25 and 2.50 g L^{-1} gave an average of 0.370 and 0.427 mg 100 g^{-1}, respectively. compared to the control treatment, which recorded 0.319 mg 100 g^{-1}. Treatment C_2B_2 recorded the highest average of 0.557 mg 100 g^{-1}, whereas treatment C_0B_0 recorded 0.173 mg 100 g^{-1}. The bi-interaction between the two study parameters revealed significant differences across treatments. The results in table (5) obtained that a foliar spray of benzyl adenine

and nano-calcium every one alone or their combination enhanced a leaf content of carbohydrate insignificantly.

Table 4: Effect of foliar spraying with benzyl adenine, nano calcium and their interaction on total carotenoids in leaves (mg 100 g^{-1})

benzyl adenine	Nano calcium			Average benzyl adenine
	C_0	C_1	C_2	
B_0	0.173 i	0.227 h	0.282 g	0.227 c
B_1	0.301 f	0.378 e	0.442 d	0.374 b
B_2	0.482 c	0.503 b	0.557 a	0.514 a
Average nano calcium	0.319 c	0.370 b	0.427 a	

Averages with similar letters do not have a significant difference according to Duncan's test at a 5% probability level.

Table 5: Effect of foliar spraying with benzyl adenine, nano calcium and their interaction on carbohydrate percent in leaves

benzyl adenine	Nano calcium			Average benzyl adenine
	C_0	C_1	C_2	
B_0	13.27 a	16.57 a	14.80 a	14.88 a
B_1	15.33 a	15.70 a	15.57 a	15.53 a
B_2	17.77 a	13.33 a	16.77 a	15.96 a
Average nano calcium	15.46 a	15.20 a	15.71 a	

Averages with similar letters do not have a significant difference according to Duncan's test at a 5% probability level.

The result of statistically analyzes in table (6) showed that the ratio of carbohydrates: nitrogen decreased with increasing the level of benzyl adenine. Spraying with high concentration of benzyl adenine (150 mg L^{-1}) decreased the carbohydrate: nitrogen ratio compared to control treatment with an average of 7.14 and 8.66 for these treatments respectively. It is also noted from the same table that spraying with nano calcium did not record any significant differences between the treatments. The bi- interaction between the study factors showed significant deference between some treatments. The B_0C_1 treatment recorded the highest ratio (9.81) and performed statistically all other treatment. On the other hand, the treatments C_1B_2 recorded the lowest average of 5.97 and decreased significantly compare the control treatment.

Table 6: The effect of foliar spraying with benzyl adenine, nano- calcium and their interaction on carbohydrates: nitrogen ratio in leaves

benzyl adenine	Nano calcium			Average benzyl adenine
	C_0	C_1	C_2	
B_0	8.56 b	9.81 a	7.62 bc	8.66 a
B_1	8.01 bc	7.50 bc	6.99 cd	7.50 ab
B_2	8.18 bc	5.97 d	7.26 c	7.14 b
Average nano calcium	8.25 a	7.76 a	7.29 a	

Averages with similar letters do not have a significant difference according to Duncan's test at a 5% probability level.

The foliar spray with benzyl adenine influenced significantly and increased leaf content of nitrogen, calcium, chlorophyll and carotenoids pigments, and carbohydrate to nitrogen ratio (Tables 2, 3,4 and 6). Benzyl adenine is a member of cytokinin group as plant growth regulators. Aloni et al. (2006) concluded that, cytokinin and IAA auxin are key hormones which regulate root vascular differentiation, lateral root initiation and root system development. Also, the presence of cytokinin in plant organs make this local active biologically and a sink of sugar, amino acids and nutrients (Wasfi, 1995), therefore the tree absorb more water and nutrient from soil and these materials concentrate in leaves and other plant organs. Benzyl adenine works with light to stimulate the formation of chloroplasts and enhance chlorophyll pigment formation (Davies, 2004). On the other hand, benzyl

adenine delays a senescence of leaves by prevent a quick decrement of chlorophyll, protein and RNA nucleic acid (Wasfi, 1995), that will save a photosynthesis pigment and increase the efficiency of the photosynthesis process and increase the synthetic carbohydrate in leaves. The results were in line of Abdel- Rahman (2011) and Al-Dulaimi (2015) when they sprayed Florida prince peach trees and Black Diyala fig seedlings with CPPU cytokinin, respectively.

The chemical constituents of fig leave such as nitrogen, calcium chlorophyll and carotenoids were affected responding to foliar spray with nano-calcium (Tables 1,2,3 and 4). The nano-calcium inter a leaf tissue when was sprayed to the leaf surfaces and concentrate there. Calcium cation mediates the signalings of multiple hormones particularly auxin, environmental cues and plant development to regulate primary root growth (Zhang et al., 2020). Calcium has a role in encouraging root growth that calcium absence ceases a root growth within a few hours (Jundiya, 2003 and Pilbeam and Morly, 2007), that may be reflected in increasing absorption of nutrients such as nitrogen and calcium, from the soil solution and thus increase their concentration in plant tissues. The abundance of nitrogen as a result of spraying with nano-calcium may be led to formation more chlorophyll in leaves, as nitrogen is an essential component of the chlorophyll molecule (Fathi, 2022). Calcium participates in the stomatal closure pathway (Wang et al., 2019) and control indirectly gas exchange and photosynthesis process in leaves. Khayyat et al. (2009) reported that, calcium protect a strawberry plant against a salinity and stimulate chlorophyll piment synthesis. Regarding to the increasing of carotenoids in fig leaves as a result of spraying nano-calcium, may be due to the role of calcium in improving the permeability of cell membranes, which leads to increased efficiency of nutrient absorption, photosynthesis, activation of many enzymes which take part in manufacturing of carotenoids (Al-Sahaf, 1989). The results are consistent with Mustafa et al. (2017) in their study of spraying calcium on fig trees and Mohamed et al. (2021) on the strawberry plants.

CONCLUSION: The leaves are the center of food synthesis and contain many chemical materials naturally, but the concentration of these components could be affected by different application, such as foliar spraying with benzyl adenine and nano- calcium that increased a concentration of some nutrients and plant pigments and then improve the growth of fig trees.

CONFLICT OF INTEREST

There are no conflicts of interest associated with this manuscript.

ACKNOWLEDGMENTS

We would like to express our profound gratitude to the employees in the Department of Horticulture and Landscape Design's labs and fields for their help in finishing this study.

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