International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 1s, 2025
https://www.theaspd.com/ijes.php

Effect of Pruning and Spraying with Gibberellins (GA3) and Cytokinins on Certain Traits of Fig Trees (Ficus carica L.)

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Abstract
This study was conducted on 5-year-old fig trees of the Black Diyala variety during the 2023-2024 season in a private orchard in Kirkuk Governorate. The one-year-old branches were pruned at rates of 20% and 40%, and the trees were sprayed with gibberellic acid and benzyl adenine at a concentration of 100 mg/L each, either individually or combined, on the 20th of March. The results showed that the treatment involving 40% pruning combined with spraying (GA3 + BA) significantly increased the leaf content of GA3, IAA, BA, total chlorophyll, and methoxalen. The highest recorded values for these traits were (39.9), (46.39), (30.68), (116.83), and (4.35), respectively. Additionally, there was a significant increase in branch length, number of branches, and total carbohydrate percentage, along with a significant reduction in fruit drop percentage and an increase in total yield, reaching (22.74), (10.73), (18.84), (4.37), and (27.1), respectively. Furthermore, there was an improvement in T.S.S. percentage, vitamin C content, anthocyanin pigment, and fruit firmness, with values of (18.13), (9.17), (455.3), and (1.689), respectively, compared to the control treatment, which exhibited the lowest values for these traits.

Keywords: Pruning, Spraying, Fig Trees-

INTRODUCTION

Fig trees (Ficus carica) are deciduous fruit trees belonging to the genus Ficus, which is part of the Moraceae family. This genus includes 400 species and 700 varieties, known for their delicious and nutritious fruit (13). Fig trees are grown in various regions worldwide, particularly in warm climates. The fig is one of the oldest cultivated trees, with a history of human cultivation spanning thousands of years, and it is recognized for its significant health benefits (10). It is believed that its original habitat is the Arabian Peninsula (21). Fig leaves contain the compound Methoxsalen, which is used in the treatment of several diseases, including vitiligo, skin cancers caused by ultraviolet radiation, and psoriasis (23);(19);(18). Pruning is the process of removing certain parts or branches of a tree to improve its growth, enhance its productivity, and maintain its health (3)(5). Pruning is an important aspect of tree care, as it helps improve the tree's shape, prevents the spread of diseases and pests, and also enhances fruit quality and supports better growth (7)(15)

Pruning is typically limited to the early years of fruit-bearing, often in winter or early spring. Winter or early spring is considered the ideal time for pruning trees (27), as the tree is in its dormant stage (the inactive cycle) (20)(9), which means that pruning does not significantly affect its growth. The second pruning period is after fruiting for fruit trees. It is preferred to prune them after harvest, removing excess branches that may affect the growth of fruits in the next season (8).

Pruning helps increase auxin levels, which in turn increases the number of leaves on branches, ensuring sufficient leaves for photosynthesis, promoting strong growth, and stimulating root activity (22)(11). This process leads to the absorption of nutrients, increases the chlorophyll content in the leaves, and improves their efficiency in photosynthesis. Consequently,

the materials are transferred from the leaves to the fruit, causing an increase in fruit weight and enhancing the trees' yield and quality traits (29).

Pruning pomegranate trees increases the leaf area and the total chlorophyll content in the leaves (12). It also enhances branch length, number, and carbohydrate content, as well as nitrogen levels (24), which in turn increases tree yield and improves the T.S.S., vitamin C, and anthocyanin content compared to unpruned trees (OSpraying fig trees with gibberellic acid (GA3) and benzyl adenine (BA) is one of the agricultural practices aimed at improving tree growth and increasing productivity, particularly by enhancing the processes of flowering, fruit set, and fruit development. This, in turn, contributes to stimulating tree growth, improving flowering, and increasing fruit size and quality. However, these practices must be applied carefully according to agricultural recommendations to avoid negative effects and ensure optimal results. (32) reported that spraying Mission fig trees with gibberellic acid and benzyl adenine at a concentration of 100 mg/L for each resulted in an increase in the leaf content of growth-promoting hormones, total chlorophyll, the number and length of branches, total carbohydrate content, and a 16-20% increase in tree productivity compared to the control, as well as improved quality traits of the yield.

The aim of this study is to investigate the effects of pruning and spraying with BA and GA3 on certain growth and yield traits of Black Diyala fig trees (Ficus carica L.).(33); (35); (4); (15); (14).

MATERIALS AND METHODS MATERIALS AND METHODS

This study was carried out on a private orchard belonging to a farmer in Kirkuk Governorate during the 2023-2024 season to study those effects of pruning treatments as well as spraying using BA and GA3 on some traits of Black Diyala fig trees. A randomized complete block design was employed and the results of this study were compared using analysis of variance (ANOVA) and Least Significant Difference (LSD) at 0.05 probability level. The research was carried out on 36 five year old fig trees planted with a spacing of 6×6 meters. The trees were flooded for irrigation and fertilized with a nitrogenous fertilizer and NPK compound twice, 1 kg per tree for each application. The experiment had 12 treatments in three replications (25)(10).

Pruning was carried out in mid-January, when the trees were sprayed with GA3 and BA in the morning until complete wetting on March 20. The treatments were as follows:

1. Control, denoted as A
2. Pruning at 20%, denoted as B
3. Pruning at 40%, denoted as C
4. Spraying with GA3 at a concentration of 100 mg/L, denoted as D
5. Spraying with BA at a concentration of 100 mg/L, denoted as E
6. Spraying with (GA3 + BA) at a concentration of 100 mg/L for each, denoted as F
7. Pruning at 20% + Spraying with GA3 at a concentration of 100 mg/L, denoted as D+B
8. Pruning at 20% + Spraying with BA at a concentration of 100 mg/L, denoted as B+E
9. Pruning at 40% + Spraying with GA3 at a concentration of 100 mg/L, denoted as D+C
10. Pruning at 40% + Spraying with BA at a concentration of 100 mg/L, denoted as C+E
11. Pruning at 20% + Spraying with (GA3 + BA), denoted as B+F
12. Pruning at 40% + Spraying with (GA3 + BA), denoted as C+F

The studied traits were measured as follows: Gibberellins (GA3), Auxins (IAA), Cytokinins (BA), total chlorophyll in the leaves, leaf content of Methoxsalen, branch length, total carbohydrates in the branches, total yield per tree, percentage of total soluble solids (T.S.S.), vitamin C content, fruit drop percentage, and fruit firmness (28);(14);(34);(17);(34).

RESULTS AND DISCUSSION

1. Leaf Content of GA3, IAA, BA, Total Chlorophyll, and Methoxsalen:

The results shown in Table (1) indicate that the treatment of pruning at 40% + spraying with (GA3 + BA) had a significant effect in increasing the leaf content of GA3, IAA, BA, total chlorophyll, and methoxsalen. The highest mean value for these traits were (39.9), (46.39), (30.68), (116.83), and (4.35) respectively and the lowest mean values were in the control treatment which were (39.9), (46.39), (30.68), (116.83) and (3.57) in order. When the plants are pruned and sprays with a chemical compound like GA3, IAA and BA such a sequential effect is created which dictates the overall growth of the plant. This also includes an enhancement in chlorophyll and methoxsalen in terms of their leaf contents. These effects are resulting from numerous physiological actions taking place after application of these compounds or after pruning. Pruning enhances the plants' response to new growth making it favorable for growth to hormone efficiency such as GA3 and BA. These hormones sprayed after pruning cause a cell division more effectively and induce the leaves to grow more. The integrated use of pruning and hormone spraying lead to enhanced plant's ability to grow fast and increase efficiency of photosynthesis leading to increased level of chlorophyll and methoxsalen. In addition, the higher leaf content of GA3, IAA, and BA (26), while pruning and spraying hormones increased the total chlorophyll and methoxsalen are attributed to the impact of these substances in cell growth activation, leaf size enlargement, and photosynthesis power. Lastly, these effects improve the health and productivity of plants (10). The increased total chlorophyll content could be due to the activation of roots in nutrient uptake and those which are involved in making chlorophyll. This process increases the amount of food production and promotes plant growth and enzymatic systems leading to increased production of growth-promoting hormones (2). These results are similar to (35),(4),(14),and(13).

Table (1): Effect of Pruning Treatments and Spraying with GA3 and BA on Some Traits of Fig Trees

Traits / Treatments	GA3	IAA	BA	Total Chlorophyll	Methoxsalen
A	39.9	46.39	30.68	116.83	**3.57**
B	41.65	48.93	35.8	119.45	**3.7**
C	43.18	50.25	39.12	120.17	**3.76**
D	46.99	51.57	40.05	120.45	**3.74**
E	44.76	51.32	42.75	122.8	**3.79**
F	48.81	54.94	45.69	123.62	**3.8**
D+B	48.05	53.16	40.56	121.97	**3.77**
E+B	45.9	52.4	43.88	124.7	**3.93**
D+C	49.53	54.78	44.79	126.34	**4.01**

E+C	47.12	53.51	47.04	130.73	**4.08**
F+B	50.68	58.85	50.62	134.38	**4.17**
F+C	54.4	62.03	56.98	139.51	**4.35**
L.S.D.0.05	1.71	2.18	4.21	2.62	**0.22**

2. Branch Length, Number, Total Carbohydrates Percentage, Fruit Drop, and Total Yield of Trees.

From Table (2) results indicate that the treatment of pruning at 40% + spraying with (GA3 + BA) had a significant increase in branch length, number, total carbohydrates percentage, and a significant reduction of fruit drop percentage and an increase in the total yield of trees. The recorded values were (22.74), (10.73), (18.84), (4.37), and (27.1), respectively, compared to the control treatment, which had the lowest values of (12.95), (4.7), (12.62), (13.06), and (19.73), respectively.Pruning contributes to improving the quality of growth by removing old or damaged parts, allowing healthy parts to more efficiently direct resources. This lead to greater total chlorophyll amounts (as well as higher concentrations of the growth-stimulating hormones) in the plant, as well as an increase in total carbohydrates, branch length and number of branches. These facts help with; reduced fruit drop, and increased tree yield resulting into an increase in overall yield. Additionally, plant hormones (GA 3 + BA + IAA) facilitate important functions in the plant, including cell division, enhanced photosynthetic productivity, and better efficiency in the transport of nutrients. As effects, over a period of time; the trees are able to support plant and fruit growth more easily. The increased total carbohydrates, branch length, and number of branches in the pruning and growth regulator treatments are attributed to the increase in total chlorophyll content, which enhances food production and the transportation and storage of excess food in the branches, as well as stimulating roots to absorb nutrients. All these processes lead to increased plant growth (23).

Table (2): Effect of Pruning Treatments and Spraying with GA3 and BA on Some Traits of Fig Trees.

Traits **Treatments**	**Branch Length (cm)**	**Number of Branches**	**Total Carbohydrates (%)**	**Fruit Drop (%)**	**Total Yield (kg/tree)**
A	12.95	4.7	12.62	13.06	**19.73**
B	13.45	6.45	14.5	10.75	**20.87**
C	14.38	7.2	15.65	9.52	**21.98**
D	15.07	4.85	16.1	7.41	**21.74**
E	14.1	7.1	15.75	8.04	**21.63**
F	15.75	7.53	16.6	5.35	**23.8**

D+B	15.41	6.71	16.96	7	**23.02**
E+B	15.15	7.5	16.71	7.21	**23.1**
D+C	17.68	7.2	18.05	6.43	**24.95**
E+C	16.87	8.7	17.13	6.68	**24.46**
F+B	20.06	9.95	18.18	5.16	**25.84**
F+C	22.74	10.73	18.84	4.37	**27.1**
L.S.D.0.05	0.43	0.82	0.73	0.86	**1.21**

3. Percentage of Total Soluble Solids, Vitamin C, Anthocyanin Pigment, and Fruit Firmness.

It can be concluded from the results of Tables (1 and 2) that the pruning treatment at 40% + spraying (GA3 + BA) led to an increase in the percentage of T.S.S., Vitamin C, anthocyanin pigment, and fruit firmness. The values were (18.13), (9.17), (455.3), and (1.689), respectively, compared to the control treatment, which had the lowest values for these traits, with (17.15), (8.13), (386.39), and (1.575) respectively.The percentage of total soluble solids (T.S.S.), Vitamin C, anthocyanin pigment, and fruit firmness are influenced by several physiological and chemical factors in the plant. These factors that affect fruit quality might have a complex relationship. Pruning processes expose tree leaves to light and thus food production and transfer to the fruit is increased as well as chemical transformation of its components is increased. This increases the fruit's stock of T.S.S., Vitamin C, carbohydrates, and pigment content in the peel (17). The increase in total soluble solids (TSS) is a result of an increase in sugars that add sweet taste to the fruit and a part of the process of formation of anthocyanin pigments. Vitamin C can help to excited enzymes that are involved in the synthesis of anthocyanins responsible not only for the color of the fruits but as well its increase in content. The increasing levels of Vitamin C and TSS can be associated with the improvement of fruit firmness as both these components are involved in fruit growth and contribute to the cell wall formation reinforcement. An increase in the percent of total soluble solids (TSS%) and Vitamin C may be attributed to the high metabolic and photosynthesis activities in the plant which is compensated by hormones such as GA3 and BA. Anthocyanin pigment is a result of vigorous synthesis of secondary compounds (flavonoids) that are caused by vigorous photosynthesis. Better fruit firmness is caused by increased metabolic activity and a desirable environmental influence on better cell wall development (31);(16);(26);(1);(17) and (39).

Table (3): Effect of Pruning Treatments and GA3 + BA Spraying on Some Characteristics of Fig Trees.

Traits Treatments	%T.S.S.	Vitamin C	Anthocyanin Pigment	Fruit Firmness (Kg/cm^2)
A	17.15	8.13	386.39	**1.575**
B	17.34	8.29	452.62	**1.586**
C	17.43	8.38	458.9	**1.597**

D	17.45	8.45	413.82	**1.605**
E	17.48	8.53	412.06	**1.611**
F	17.56	8.6	449.8	**1.624**
D+B	17.65	8.71	452.03	**1.629**
E+B	17.53	8.7	452.71	**1.63**
D+C	17.7	8.82	454.45	**1.647**
E+C	17.81	8.91	441.46	**1.656**
F+B	17.95	9.04	436.81	**1.67**
F+C	18.13	9.17	455.3	**1.689**
L.S.D.0.05	0.21	0.20	2.72	**0.021**

CONCLUSION

Pruning and spraying with BA and GA3 have beneficial effects on the growth, productivity, and quality of fruits of the fig trees of the "Black Diyala" variety. However, it is necessary to perform accurate field experiments to define the optimal amounts of these factors and the optimal timing of their application to obtain the most favorable results. Based on the results of the study, it is concluded that pruning treatments and spraying with GA3 and BA, in particular, pruning branches by 40% accompanied by spraying (BA + GA3) at a concentration of 100 mg/L each, resulted in enhanced all studied traits in comparison with the control treatment.

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