Assiut Journal of Agricultural Sciences 54 (3) 2023 (135-144) Website: http://ajas.journals.ekb.eg/
ISSN: 1110-0486 / EISSN: 2356-9840 E-mail: ajas@aun.edu.eg

(Original Article)

Effects of GA_3 and Plant Extracts Spraying on Aggezi Olive Tree Growth and Fruiting in Sohag Governorate, Egypt

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DOI: 10.21608/ajas.2023.213813.1262

Abstract

A Horticultural Station orchard in the Shandaweel region of the Sohag Governorate, Egypt, was the site of this study, which was conducted on mature Aggezi olive cv. (16-year-old) during the 2020 and 2021 growing seasons. This research intends to determine the impact of spraying GA_3, lemongrass, and moringa leaf extract on the growth and fruiting of Aggezi olive trees, which are uniform in shape and planted in silty clay loam soil using drip irrigation systems. The results demonstrated that all spraying treatments with GA_3, lemongrass, and moringa extracts enhanced vegetative development, fruit set, yield, and fruit chemical features in comparison to the control. The best treatments comprised 4% extracts of lemongrass or moringa leaves to increase vegetative growth, fruit set, yield, and oil content. Thus, these treatments can be recommended for commercial use under similar conditions.

Keywords: *Olive, Lemongrass, Moringa, Vegetative growth, Yield, Fruit quality*

Introduction

One of the oldest agricultural products with exceptional economic and cultural significance in the Mediterranean Basin is the olive tree (*Olea europaea* L.). It is also a fruit tree that grows abundantly over the world. (FAO, 2019). Numerous cultivars of the olive are used for pickling and oil extraction and it can grow in a variety of soil types and growth environments. The majority of the olive trees in Egypt are grown in recently reclaimed land, which typically has poor sandy soil. Successful and good orchard management is linked to obtaining a large output with good fruit and oil qualities. Olive cultivation gradually expanded until it covered 257.896 feddan, yielding 1056548 tons at an average yield of 4.10 tons per feddan. (M.A.L.R., 2021).

Gibberellins are plant growth regulators that control the growth and development of higher plants. At least three of GA_3's functions are crucial: it raises an organ's ability to operate as a nutrient sink; it boosts the production of IAA in plant tissues; and it quickens the production of hydrolytic enzymes. Thus, the

Received: 28 May 2023/ Accepted: 18 June 2023/ Published online: 1 July 2023

initial cells in the developing tissues and growth centers elongated as a result of the application of GA_3. (Davis, 2004; Chang and Lin, 2006 and Zhang *et al*., 2007).

Due to their ability to upset the ecological balance of soils and increase plant susceptibility to pests and diseases, frequent and excessive use of chemical inputs has been charged with having negative impacts on the quality of the environment. (Fawzy *et al*. 2012).

There are numerous uses for plant extracts as natural products. In order to improve growth, nutritional status, productivity, and pesticides for environmental and public health safety, natural materials were used. Plant extracts included higher concentrations of phenolic and other chemical elements that appear to work in concert to promote fruit tree development and fruiting. (Paik and Chung, 1997 and Srivastava and Lal, 1997)

Due to its high citral concentration, lemongrass (*Cymbopogan citrates* L.) is one of the most significant essential oils. Terpenes, alcohols, ketones, aldehydes, esters, and flavonoids are all present in it. (Shab *et al*., 2011). Higher concentrations of nutrients, antioxidants, and plant pigments found in plant extracts, which in turn promote fruit trees' development and fruiting, (Pons, 2003 and El-Salhy *et al*., 2017).

The moringa leaf extract is a source of zeatin, proteins, phenols, vitamin E, ascorbic acid, vital amino acids, and various mineral elements, making it a possible natural growth stimulant. As a result, it is thought to be a natural plant growth regulator. (Howladar, 2014 and Rady *et al*. 2015).

Therefore, this work is aimed to investigate the effect spraying of GA3, lemongrass and moringa leaf extract on the growth, yield and fruit quality of Aggezi olive trees.

Materials and Methods

This research was done on Aggezi cultivated in a horticulture station orchard in the Shandaweel area of the Sohag Governorate, Egypt, over the course of two successive growing seasons in 2020 and 2021. A drip irrigation system was used to water 16-year-old olive trees that were spaced 6 x 6 meters apart in silt clay loam soil. The chosen trees were uniform in shape and had undergone standard horticultural procedures. Different concentrations of GA_3, lemongrass, and moringa leaf extract were sprayed on the chosen trees. During the two seasons under consideration, the experiment was set up as a randomized complete block design with three replications, one tree per distinct group of trees as follows:

1. Tree spray with GA_3 at 100 ppm.
2. Tree spray with moringa leaves extract at 2%.
3. Tree spray with moringa leaves extract at 4%.
4. Tree spray with lemongrass extract at 2%.
5. Tree spray with lemongrass extract at 4%.

6. Control treatment (spray with water only)

All trees under study received two sprayings: once at the beginning of growth and once after fruit set. The following measurements were taken on twenty healthy one-year-old shoots that were evenly dispersed over the canopy.

Vegetative parameters:

At the end of each growing season, during first week of September the following characteristics were measured.

1-Number of leaves per shoot

2-Leaf area (cm^2) according to Ahmed and Morsy (1999)

3-Leaf total chlorophyll was measured by chlorophyll water (Minolta SPAD 502 plus).

Blooming characteristics: Number of inflorescences per shoot.

Sex expression percentage.

Fruit Set:

Following fruit set and just prior to harvest, the initial fruit set fruiting and fruit retention percentages were determined as follows:

$$\text{Initial fruit set (\%)} = \text{number of fruit/total flowers number at full bloom x } 100$$

$$\text{Fruit retention \%} = \text{number of fruit/total setting fruit x } 100$$

Yield: Depending on the weight of fruits per tree for all plants, fruits were manually collected at the peak of ripeness from each individual tree. Each treatment's average yield (in kilograms) per tree was calculated.

Physical fruit properties:

Thirty fruits were randomly taken from each replicate to estimate the physical fruit quality in terms of weight, flesh % and dimensions.

Properties of fruit:

Fruit oil content %: Using a soxhlet oil extraction device with hexane's 60–80 °C boiling point, the oil percentage in the fruit flesh was calculated on a dry weight basis. Banat *et al* (2013).

The gained data were statistically analyzed according to Gomez and Gomez (1984) and Mead *et al*. (1993) using the New L.S.D. values at 5% to determine the significance of differences among various treatment means.

Results

Vegetative Parameters

According to the findings in Table 1, spraying GA_3, lemongrass, and moringa leaf extract greatly improved the length of the shoots and the quantity of leaves that were present on each shoot. Given that the average length of the two examined seasons was 20.49 cm and 33.59 leaf/shoot, respectively, moringa leaf extract at

4% provided the highest value in this regard for tree spray. The lowest value was subjected to control treatment (20.48 cm and 21.98 leaf/ shoot, respectively). There were no significant differences with 100 ppm GA_3 or 4% moringa, as well as GA_3 or 4% lemongrass spraying. The percentage increasing shoot length was (40.14, 43.99 and 36.91) and leaf number/shoot was (48.09, 49.71 and 43.23% as an av. of two studied seasons) due to spray 100 ppm GA_3, 4% moringa or 4% lemongrass than unsprayed one (control), respectively.

Table 1. Effect of foliar application GA_3, moringa and lemongrass on vegetative growth of Aggezi olive trees during 2020 and 2021 seasons

Treatment	Shoot length (cm)			Leaf No/shoot			leaf area (cm^2)			Chlorophyll (SPAD)		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
GA_3	28.28AB	29.11AB	28.70	32.00AB	33.10AB	32.55	4.45A	4.16A	4.31	115.6AB	119.5AB	117.6
Moringa 2%	27.31B	28.16BC	27.74	31.50B	32.62B	32.06	3.76B	3.82BC	3.79	106.2C	109.5C	107.9
Moringa 4%	29.10A	29.88A	29.49	33.0A	34.18A	33.59	4.40A	4.23B	4.32	118.5A	121.8A	120.2
Lem. 2%	26.74B	27.42C	27.08	30.83B	31.83B	34.44	3.66B	3.65C	3.66	103.4C	106.9C	105.2
Lem. 4%	27.61B	28.47B	28.04	31.50B	32.70AB	32.10	4.26A	3.98B	4.12	111.9B	115.7B	113.8
Control	20.18C	20.78D	20.48	21.13C	22.83C	21.98	3.43C	3.33D	3.38	94.8D	96.9D	95.9
New LSD 5%	0.91	0.94		1.28	1.53		0.20	0.18		4.62	4.28	

Results in the same table show that all treatments increased in terms of leaf area and total leaf chlorophyll. These examined characteristics were contrasted with the control group. The maximum leaf area (4.31 and 4.32 cm^2) and total chlorophyll (117.69 and 120.25 SPAD), as an average of the two study seasons, were found in trees sprayed with GA_3 or moringa leaf extract at 4%, respectively. The value one was receiving the control treatment at the time (3.38 cm^2 and 95.95 SPAD, respectively). Furthermore, spraying GA_3, 4% moringa, or 4% lemongrass had no discernible impact. The increment percentage of leaf area attained (27.51, 27.81 and 21.89%) and total chlorophyll attained (22.62, 25.34 and 18.67 as an av. of the two studied seasons) due to spray GA_3, 4% moringa or 4% lemongrass compared unsprayed one (control), respectively.

Fruit set and yield kg/tree

In accordance with the findings shown in Tables 2 and 3, all treatments significantly increased fruit set, sex expression, fruit retention, and yield as compared to the control. The least sex expression (38.11), least fruit retention (7.70), and least amount of fruit produced per tree (37.1 kg on average during the two study seasons) were seen in untreated plants (control). Trees receiving 4% moringa or 4% lemongrass, on the other hand, produced the most fruit per tree (45.5 and 42.6 kg as an average of the two examined seasons), as well as the highest levels of sex expression (42.13% and 42.25%), fruit set (19.63 and 19.59%), fruit retention (9.25 and 9.26%), and yield per tree (19.63 and 19.59%). Hence, the increment percentage due to spray GA_3, 4% moringa or 4% lemongrass over unsprayed one (control) attained (15.36, 22.64 and 14.82 as an av. of the two studied seasons), respectively. No significant difference due to spray GA_3, moringa or lemongrass. From the previous results and from the environmental and

economic point of view, it could be concluded that is necessary to spray moringa or lemongrass extracts that improve the growth and increase the yield production without harming the environment.

Table 2. Effect of foliar application GA_3, moringa and lemongrass on inflorescence traits and fruit set of Aggezi olive trees during 2020 and 2021 seasons

Treatment	No. of inflorescence/shoot			Sex expression %			Initial fruit set %			Fruit retention		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
GA_3	14.25A	8.95A	11.60	38.83A	41.35A	40.09	19.71A	20.16AB	19.94	8.67B	8.96B	8.82
Moringa 2%	14.25A	8.81A	11.53	39.32A	42.36A	40.84	18.63B	19.10B	18.87	8.85AB	9.11AB	8.98
Moringa 4%	14.38A	8.75A	11.57	40.47A	43.58A	42.03	19.28AB	19.98AB	19.63	9.10A	9.40AB	9.25
Lem. 2%	14.13A	8.75A	11.44	39.59A	42.30A	40.95	18.81B	19.31B	19.06	8.77AB	9.11AB	8.94
Lem. 4%	14.00A	8.50A	11.25	40.85A	43.65A	42.25	19.25AB	19.93AB	19.59	9.06AB	9.45A	9.26
Control	6.38B	5.11B	5.75	36.79B	39.43B	38.11	17.63C	18.03C	17.83	7.58C	7.81C	7.70
New LSD 5%	**0.28**	**0.25**		**2.11**	**2.41**		**0.85**	**1.02**		**0.42**	**0.44**	

Fruit quality and oil content

From the data in Tables 3 and 4, it is evident that during both seasons, all spraying treatments greatly improved the dry basis oil content and physical fruit features compared to the control. The heaviest fruit (10.85 g) and the highest oil content (13.40 and 12.72%) were produced by trees treated with 4% moringa or 4% lemongrass, respectively. The control trees, on the other hand, showed the lowest fruit weight (7.74 and 7.94 as an average) over the course of the two research seasons. The other therapies, meanwhile, were in the middle of the spectrum. Hence, the increment percentage of fruit weight (40.18 and 39.15%) and oil content (68.76 and 59.57% as an av. of the two studied seasons) due to spray 4% moringa or 4% lemongrass compared to control, respectively.

Table 3. Effect of foliar application GA_3, moringa and lemongrass on yield and fruit traits of Aggezi olive trees during 2020 and 2021 seasons

Treatment	Yield/tree (kg)			Fruit weight			Flesh %			Flesh thickness (cm)		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
GA_3	46.2AB	39.4B	42.8	9.99B	9.81B	9.90	83.20A	80.37AB	81.79	0.64	0.66	0.65
Moringa 2%	43.8B	37.3B	40.6	18.27D	8.56C	8.42	81.48A	78.95AB	80.22	0.59	0.60	0.60
Moringa 4%	48.6A	42.3A	45.5	10.69A	11.00A	10.85	84.55A	81.76A	83.16	0.67	0.69	0.68
Lem. 2%	44.2B	37.7B	41.0	9.17C	9.00C	9.09	81.76A	78.28B	80.02	0.61	0.60	0.61
Lem. 4%	45.8A	39.3B	42.6	10.85A	10.68A	10.77	82.85A	80.13AB	81.49	0.65	0.67	0.66
Control	40.3C	33.9C	37.1	7.80E	7.68D	7.74	77.80B	74.63C	76.11	0.54	0.55	0.55
New LSD 5%	**2.85**	**2.29**		**0.38**	**0.49**		**3.36**	**2.98**		**0.03**	**0.03**	

Table 4. Effect of foliar application GA_3, moringa and lemongrass on fruit dimension and oil % of Aggezi olive trees during 2020 and 2021 seasons

Treatment	Fruit height (cm)			Fruit diameter (cm)			Oil %			No. of flower/inflorescence		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
GA_3	3.05AB	3.01AB	3.03	2.61AB	2.58AB	2.60	12.53B	12.28B	12.41	20.9B	21.6B	21.3
Moringa 2%	2.97B	2.94B	2.96	2.54B	2.52A	2.53	11.35C	11.44C	11.40	21.4AB	22.5A	21.9
Moringa 4%	3.06AB	3.01AB	3.04	2.65A	2.63A	2.64	13.34A	13.45A	13.40	21.8AB	22.8A	22.3
Lem. 2%	3.07AB	3.04AB	3.06	2.63AB	2.59AB	2.61	11.24C	11.30C	11.27	21.00B	21.7B	21.4
Lem. 4%	3.11A	3.07A	3.09	2.67A	2.65A	2.66	12.78B	12.56B	12.67	22.0A	22.9A	22.5
Control	2.67C	2.64B	2.66	2.28C	2.23C	2.26	7.85D	8.02D	7.94	18.5C	18.8C	18.7
New LSD 5%	**0.13**	**0.11**		**0.09**	**0.10**		**0.31**	**0.33**		**0.80**	**0.66**	

Discussion

GA_3 promotes cell elongation, improving water absorption and promoting protein production, which will lengthen the fruit's dimensions as well as its size and weight. (Dokoozlian and Peacock, 2001; El-Salhy *et al*., 2009 and Abu-Zahra, 2010).

The outcomes are consistent with those of Emongor (2012), Rady *et al* (2013), Howladar (2014) and Rady *et al*. (2015) who noticed that moringa leaf extract, which is regarded as a natural plant growth stimulant and is the source of zeatin (a natural derivative of cytokinin), proteins, ascorbates, phenols, several mineral elements, and essential amino acids, may be responsible for the improvement in vegetative growth and leaf mineral content as a result of foliar sprays with moringa extract. According to some findings, moringa extract functions as a plant hormone that promotes crop growth. (Bashir *et al*., 2014 and Rehman *et al.*, 2014).

The acquired results are in agreement with those of since spraying morniga extract improves fruit set, yield, fruit chemical qualities, as well as oil content. Thomas and Howarth (2000), who demonstrated that the use of moringa extract, which contains zeatin-like cytokinin and may stimulate cytokinin biosynthesis, produced the greatest number of photo synthetically active leaves. This is clear from the quantity and size of leaves produced by each plant, which help to maintain higher chlorophyll concentrations and influence plant yield. Additionally, foliar applications of moringa that are sufficiently stimulant-rich promote increased cell division and cell enlargement, strengthen plants, and eventually result in greater and more plentiful crops. (Fuglie, 2000). In addition, these results are in harmony with those obtained by Abd El-Motty and Abd El-migeed (2010), Hafez *et al*. (2013), Ahmed *et al*. (2014), Abed El Hamied (2014) and Hassan *et al*. (2019) They claimed that spraying with plant extracts from natural plants was particularly efficient at increasing fruit set, fruit retention, yield, and fruit quality. (Hegab *et al*., 2005 and Hafez *et al*. 2013).

Conclusion

From the aforementioned findings, it can be deduced that using GA_3, moringa, or lemongrass extract on plants is regarded as an environmentally friendly method of enhancing plant development and enhancing fruit set, yield, and chemical characteristics. The most successful treatments to boost vegetative growth, enhance leaf, fruit set, yield, and oil content were those using moringa or lemongrass at 4% extract. As a result, these treatments are suitable for commercial use in similar circumstances.

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تأثير رش حمض الجبريلليك والمستخلصات النباتية على نمو وإثمار أشجار الزيتون العجيزي تحت ظروف محافظة سوهاج المناخية– مصر

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الملخص

أجريت هذه الدراسة خلال عامي 2020 و2021 على أشجار الزيتون العجيزي المنزرعة بالمزرعة البحثية لمحطة البحوث الزراعية – شندويل – سوهاج – مصر. بغرض دراسة تأثير الرش بحمض الجبريلليك ومستخلص المورينجا وحشيشة الليمون على النمو ا لخضري والمحصول وخصائص الثمار ونسبة الزيت- حيث تم رش الأشجار مرتين في بداية النمو وبعد العقد بأي من حمض الجليليك 100 جزء في المليون، المورينجا 2، 4% أو حشيشة الليمون 2 أو 4% وقد صممت التجربة بنظام القطاعات كاملة العشوائية في ست معاملات وثلاثة مكررات لكل معاملة شجرة لكل مكررة.

وقد أوضحت النتائج

سببت جميع معاملات الرش زيادة معنوية في طول الفرع وعدد الأوراق/فرع ومساحة الأوراق ومحتوي الأوراق من الكلوروفيل الكلي مقارنة بالرش بالماء (معاملة المقارنة).

سبب الرش بأي من حمض الجبريلليك أو مستخلص المورينجا أو حشيشة الليمون زيادة معنوية لكل من عدد النورات الزهرية ونسبة الجنس وكذلك نسبة العقد والعقد النهائي والمحصول/شجرة مقارنة بالرش بالماء.

سجلت أفضل النتائج نتيجة الرش بمستخلص المورينجا أو حشيشة الليمون بتركيز 4% لكل منهما.

سبب الرش بكل من GA_3 أو مستخلص المورينجا أو حشيشة الليمون زيادة معنوية في وزن وحجم الثمار ونسبة الزيت بها مقارنة بالرش بالماء (معاملة المقارنة).

من النتائج السابقة ينصح بالرش بمستخلص المورينجا أو حشيشة الليمون بتركيز 4% مرتين وذلك بعد بداية النمو وبعد العقد وذلك لتحسين النمو الخضري وزيادة عقد الثمار والمحصول وكذلك نسبة الزيت بالثمار لأشجار الزيتون العجيزي النامية تحت نفس ظروف التجربة.