International Journal of Plant & Soil Science

Volume 35, Issue 19, Page 191-199, 2023; Article no.IJPSS.104827
ISSN: 2320-7035

Effect of Foliar Spray of Micronutrients and Plant Growth Regulators on Flowering, Fruit Set and Fruit Quality of Olive Cultivars (*Olea europaea L.*)

B. C. Srujan [a++*], Saket Mishra [a#] and Vijay Bahadur [a†]

[a] *Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj, U.P., India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i193542

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/104827

Original Research Article

Received: 07/06/2023
Accepted: 11/08/2023
Published: 17/08/2023

ABSTRACT

Aim: To determine the effect of different micronutrient applications olive for its growth quality.
Study Design: Randomized Block Design was used in experiments.
Place and Duration: The present investigation was carried out at the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during the 2021-2022.
Methodology: The use of micronutrients sprays in olive cultivation is a common practice to address nutrient deficiencies, enhance plant health and increase flowering and improve fruit quality. These sprays contain essential minerals like iron, zinc, manganese, and boron, which are readily absorbed by the olive trees through their leaves. Micronutrients sprays help to correct imbalances, improve nutrient uptake, and boost overall growth and fruit development. They are particularly

[++] *M.Sc. Scholar;*
[#] *Assistant Professor;*
[†] *Associate Professor;*
**Corresponding author: E-mail: srujan1698@gmail.com;*

effective in regions with poor soil conditions or where specific micronutrient deficiencies are prevalent, ensuring healthy olive trees and optimal yield of high-quality fruits.

Results: Among the various treatments applied to enhance the Flowering, Fruit set, fruit Yield, Fruit quality and Oil quality of Olive cultivars, treatment T_{10} (Boron @ 150 ppm + Zinc @ ppm + NAA@ 150 ppm + GA3 @ 150 ppm) was found to be superior among others, followed by treatment T_5 (Boron @ 100ppm + Zinc @ 100 ppm + NAA @ 100ppm + GA3 @ 100ppm) and treatment T_0 (control) was found to be inferior. It is also concluded that among all cultivars, Arbequina cultivar was found best. Thus, treatment T_{10} (Boron @ 150 ppm + Zinc @ ppm + NAA@ 150 ppm + GA3 @ 150 ppm) with Arbequina cultivar is best recommended for overall flowering and fruiting characters of olive like, days to flowering, number of flowers per panicle, fruit drop percentage, fruit diameter, fruit length, fruit weight, fruit yield per tree, fruit yield per hectare, oil content, total suspended solids (TSS) of fruit.

Conclusion: Therefore, T_{10} (Boron @ 150 ppm + Zinc @ ppm + NAA@ 150 ppm + GA3 @ 150 ppm) with Arbequina cultivar is recommended for growing.

Keywords: Olive; micronutrients; plant growth regulators; boron; zinc; NAA; GA3.

1. INTRODUCTION

Olive is native to the Mediterranean region; botanical name of Olive is *Olea europaea* and it belongs to the Oleaceae family. It is an evergreen tree with a height ranging from 12-15 meters. Olive is characterized by its silvery-green leaves, tiny whitish flowers, and small oval shaped fruits [1-3]. Olive trees are evergreen in nature and they can tolerate adverse edaphic conditions including high temperature and draught; these abilities of olive tree make it one of the hardy crops and bear fruits even during the tough environmental challenges. Olive trees are alternate bearers; they produce important yield for one year and lower yield in the succeeding year. Olive is of major agricultural importance in the Mediterranean region as the source of olive oil (Bertrand et al. 2002) [4]. Olive is one among the oldest cultivated crops known, it holds a significant historical, cultural, medicinal, and economic importance in numerous countries. Olive is most widely cultivated in Mediterranean countries namely, Spain, Greece, Italy, Turkey, Portugal, and Tunisia. In India olive cultivation is pertained to Parts of Rajasthan, Himachal Pradesh, Uttar Pradesh, and Delhi. In the world, the olive area and production are 10,839,026 ha and 18,083,800 tons respectively (F.A.O., 2021). Olives are primarily used for oil extraction apart from this oil is also consumed as snacks, pickles [5-8]. Although, olive tree has been designated as a drought tolerant yet, it requires sufficient soil moisture during certain stages of growth. Unfortunately, majority of olive plantations were undertaken on hill slopes, in the drought prone areas of mid hills and valley areas of the state [9-14]. Furthermore, these areas are completely devoid of irrigation facility. An erratic trend of monsoon and winter rains has become more conspicuous in the last decade which further aggravated the problem of poor growth and bearing of olive trees [15-19]. Acute water stress during autumn coupled with scanty or insufficient and irregular rainfall distribution [20-22]. Boron induces pollen tube growth resulted from its role on tryptophan synthesis as an auxin precursor biosynthesis [23-25]. The main function of boron is related to cell wall strength and development, cell division, sugar transport and hormones development, RNA metabolism, respiration, indole acetic acid (IAA) metabolism and as part of the cell membranes. Lewis (1980) [26]. speculated that B may be required in stigma and styles to physiologically inactivate callus present in pollen tube walls that would otherwise elicit phytoalexin production to inhibit pollen tube growth. The boron requirement is much higher for reproductive growth period than for vegetative growth and increases flower production and retention, pollen tube elongation and germination, and seed and fruit development [27,28]. Several investigators studied the effect of zinc and/or boron on fruit set, productivity, and fruit quality in many plant species. Talaie et al. (2001) [29] showed that foliar spray of B and Zn decreased fruit drop and increased fruit quality in the 'Zard' olive. Hassan et al. (2010) [30] found that boric acid treatments increased pollen germination than control and increased percentage of retained fruits in 'Picual' olive. Abd El-Migeed et al. [31] on 'Picual' olive reported that boric acid spray at 300 mgl-1 increased fruit length. Osman (1999) [32] on olive found that boron treatments either as foliar or soil applications increased percentage of retained fruits. He also reported that boric acid at 1500 mgl-1 on 'Shahany' date palm increased pulp weight, pulp/seed ratio; fruit length and diameter. Plant growth regulators or Phytohormones play a very important role in modification or regulation of the physiological processes in plants [33-37]. Among Phytohormones NAA and GA_3 play a key role in Flowering, and Fruit set of Olive. Plant growth regulators are applied to plants through various methods but, Plant growth regulators when applied through Foliar spray gives desired results within a short span of time since, they are easily absorbed by plant tissues when applied directly on different plant parts [38,39]. NAA plays a major role in strengthening the root system by new root initiation in the plants [40-48]. It enables proper functioning of roots which transport water, nutrients and other needed elements for vegetative and floral growth of the tree [49-52]. NAA application in olive is mostly done for the purpose of fruit thinning in order to avoid overcrowding of fruits on the branch [53,54]. Application of NAA reduces excess number of fruits on the branch thus promoting the growth of evenly spaced fruits on branch and directly plays a major role in increasing the overall fruit quality of Olive Arnon et al. (2017) [55]. Gibberellic acid plays a major role when applied on Olive trees through Foliar spray. It promotes cell enlargement and mesocarp development of Olives, which is a desirable character in increasing the fruit size and fruit quality of Olive [56-60]. GA_3 also helps in reduction of fruit drop and increases the fruit retention in Olive trees [61,62]. Since GA_3 directly regulates elongation, enlargement and growth of cells thus increasing the fruit length and diameter of the olive fruits. Ramezani and Tiwari (2015) [63].

2. MATERIALS AND METHODS

The present investigation was done to understand the plant growth, fruit yield and quality of olive using different sprays of micronutrients. The details of the materials used, and the methods adopted in the investigation, which was carried out at Horticultural Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (India) during the *Winter* season of 2022-23. The design used in study was randomized block design (RBD) each treatment was replicated thrice. The data were statistically analysed (by the method suggested by Fisher and Yates (1963) [64]. The treatments comprised of T_0 (Control), T_1 (Boron @ 100 ppm), T_2 (Zinc @ 100 ppm), T_3 (NAA @100 ppm), T_4 (GA_3 @ 100 ppm), T_5 (Boron@ 100 ppm+ Zinc @ 100 ppm + NAA @100 ppm +GA_3 @100 ppm), T_6 (Boron @ 150 ppm), T_7 (Zinc @ 150 ppm), T_8 (NAA @150 ppm), T_9 (GA_3 @ 150 ppm) and T_{10} (Boron @ 150 ppm+ Zinc @ 150 ppm + NAA @150 ppm + GA_3 @ 150 ppm). Spraying was done prior to fruit harvest at time of formation of fruit. Observations were recorded at different stages of growth periods for characters like days to flowering, number of flowers per panicles, days to flowering to fruiting, fruit length, fruit diameter, fruit weight. Chemical parameters like oil content, TSS etc were also calculated. Fruit weight was calculated after harvest using electronic balance. TSS was measured using refractometer.

3. RESULTS AND DISCUSSION

3.1 Flowering Attributes

3.1.1 Influence of foliar spray of micronutrients and plant growth regulators on days to flowering, number of flowers per panicles

Days to flowering showed that there were significant differences among the treatments. The minimum days to flowering (13.33) was recorded under the treatment T_{10} which is at par with T_5 (15.33) followed by the treatment T_9 (18.33) T_8 (19.33) respectively. The maximum days to flowering (28.67) was recorded under the treatment T_0 (Control) followed by the treatments T_1 (26.67) and T_2 (26.00) respectively. The maximum number of flowers per panicle (26.00) was recorded under the treatment T_{10} which is at par with treatment T_5 (24.33) which is followed by the treatment T_9 (22.00) flowers respectively. The minimum number of flowers per panicle (9.33) was recorded in the treatment T_0 (Control) and followed by the treatments T_1 (13.33) followed by T_2 (15.67) flowers respectively. The maximum flowers per panicle was observed in T_{10}. Significant improvement in flowering and fruiting components such as the number of flowers per shoot, fruit set (%), fruit drop (%) and fruit retention (%) as influenced by increasing levels of NAA and boron treatments was observed. Combined form of micronutrients and GA_3 plays a vital role in prompting proper growth, increasing flower production and retention, pollen tube elongation and germination, and seed and fruit development by Regulating plant's hormone levels. Not only it regulates the flowering but also plays an important role in controlling the flower drops. The similar experiment was also conducted by Aftab, 1994 and found the use of zinc, boron and growth regulators on flowering, fruiting, and maturity of litchi. The obtained results are close with that obtained by Shaheen (1995), Osman (1999), and Hassan (2000) [30] on Olive. The minimum days to flowering in T_{10} might be since Boron plays an essential role in plant's life cycle and very essential for normal growth of plants. [Fageria et al*.* (2007), McLaughlin et al*.* (1999)]. While Significant improvement in flowering and fruiting components such as the number of flowers per shoot, fruit set (%), fruit drop (%) and fruit retention (%) as influenced by increasing levels of NAA and boron treatments was observed during the present investigation. Similar results were also seen in the experiment conducted by Badal and Tripathi (2021) on olive (*Psidium guajava* L. *cv* L-49).

3.2 Fruiting Attributes

3.2.1 Influence of foliar spray of micronutrients and plant growth regulators on Percent of fruit drop, Fruit weight, fruit length, fruit diameter and fruit volume

Fruit drop Percentage showed that there were significant differences among the treatments. Minimum fruit drop percentage (19.67) was recorded under the treatment T_{10} followed by T_5 (21.33), T_9 (25.67) which was at par with T_8 (27.00). Maximum fruit drop percentage (37.00) was recorded under the treatment T_0 (Control) followed by T_3 (34.33) is followed by T_1 (34.67). The least percent of fruit drop were observed in the treatment T_{10}. Environmental factors are key responsible for the fruit drop in most of the species. Application of GA_3 with the combination of micronutrients have shown greater responses against the fruit drop. Similar results were also obtained in (Nagy & Kovacs, 2005).

Fruit diameter showed that there were significant differences among the treatments. Maximum fruit diameter (16.67) was recorded under the treatment T_{10} is at par with T_5 (15.67) followed by T_9 (13.67) respectively. Minimum fruit diameter was recorded under the treatment T_0(control) (7.67) which is at par with T_1 (8.00) and T_2 (8.33) respectively. Fruit length showed that there were significant differences among the treatments. Maximum fruit length (23.00) was recorded under the treatment T_{10} followed by T_5 (21.77), T_9 (20.33) and T_8 (19.17) which was at par with T_7 (18.33). Minimum fruit length (12.83) was recorded under the treatment T_0 (Control) which is at par with T_1 (13.37). Maximum fruit weight (4.23) was recorded under the treatment T_{10} followed by T_5 (4.00), T_9 (3.57) which was at par in with T_8 (3.40). Minimum fruit weight (1.63) was recorded under the treatment T_0 (Control) followed by the treatments T_1 (1.90), T_2 (2.23) respectively. Present investigation showed that the maximum fruit weight on an average (4.23kg) was obtained in T_{10} as compared to control (1.63kg). It might be due to use of growth regulators to improve the use of stored carbohydrates, nitrogen and other variables, Singh (2013) in *Citrus limon*, Kaur Sukhjit (2017) in Florida guard peach and Siddiqua et al*.* (2018) in dragon fruit, also recorded these results.

3.2.2 Influence of foliar spray of micronutrients and plant growth regulators on Fruit yield per tree and fruit yield per hectare

Maximum fruit yield per tree (3.10) was recorded under the treatment T_{10} followed by T_5 (2.57), T_9 (1.73) and T_8 (1.50) respectively. Minimum fruit yield per tree (0.34) was recorded under the treatment T_0 (control) followed by T_2 (0.59). The maximum yield obtained was (12.40 q/ha) T_{10}. Fruit yield per hectare showed that there were significant differences among the treatments. Maximum fruit yield per hectare (12.40) was recorded under the treatment T_{10} followed by T_5 (10.27). Minimum fruit yield per hectare (1.37) was recorded under the treatment T_0 (control) followed by T_2 (Zinc @ 100 ppm) (2.35), T_3 (2.45) respectively. The beneficial effect of boron and zinc in increasing fruit yield might be due to the higher availability of photosynthesis, and/or their role in increasing the percent of perfect flowers and these chemicals are also associated with hormone metabolism which promotes synthesis of auxin, essential for fruit set and growth. The results are in accordance with Kazemi (2014). Similar results of increased yield due to the application of $ZnSO_4$ were reported by Pathak et al*.* (2004) in olive.

3.3 Quality Parameters

3.3.1 Influence of foliar spray of micronutrients and plant growth regulators on TSS, oil content

Oil content showed that there were significant differences among the treatments. Maximum Oil content (20.83) was recorded under the treatment T_{10} followed by T_5 (19.70), T_9 (18.67) respectively. Minimum Oil content (10.20) was recorded under the treatment T_0 (Control)

Table 1. Performance of different micronutrients application on various parameters of olive

Treatment symbol	Treatment Details	Days to flowering	Flowers per panicle	Fruit drop (%)	Fruit Diameter (mm)	Fruit length (mm)	Fruit weight (g)	Fruit yield (Kg/tree)	Fruit yield (q/h)	Oil content (%)	TSS (°Brix)
T_0	Boron @ 100 ppm	28.67	9.33	37.00	7.67	12.83	1.63	0.34	1.37	10.20	10.10
T_1	Zinc @ 100 ppm	26.67	13.33	34.67	8.00	13.37	1.90	0.49	1.95	11.53	10.60
T_2	NAA @100 ppm	26.00	15.67	31.33	8.33	14.00	2.23	0.59	2.35	12.73	10.90
T_3	GA_3 @ 100 ppm	25.00	16.33	34.33	9.67	15.07	2.60	0.61	2.45	13.17	11.17
T_4	Boron@ 100 ppm+ Zinc @ 100 ppm + NAA @100 ppm +GA_3 @100 ppm	23.00	17.00	31.00	10.00	16.33	2.80	0.87	3.49	14.60	11.50
T_5	Boron @ 150 ppm	15.33	24.33	21.33	15.67	21.77	4.00	2.57	10.27	19.70	13.37
T_6	Zinc @ 150 ppm	21.33	20.00	30.00	11.00	17.43	3.00	1.01	4.04	15.20	11.80
T_7	NAA @150 ppm	20.67	20.67	28.33	12.33	18.33	3.10	1.20	4.80	16.77	12.13
T_8	GA_3 @ 150 ppm	19.33	21.33	27.00	13.67	19.17	3.40	1.50	6.00	17.13	12.60
T_9	Boron @ 150 ppm+ Zinc @ 150 ppm + NAA @150 ppm + GA_3 @ 150 ppm	18.33	22.00	25.67	14.00	20.03	3.57	1.73	6.93	18.67	12.90
T_{10}	Boron @ 100 ppm	13.33	26.00	19.67	16.67	23.00	4.23	3.10	12.40	20.83	13.80
F-Test		**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.E.(m) (±)		**1.28**	**1.17**	**0.97**	**0.66**	**0.40**	**0.08**	**0.07**	**0.31**	**0.13**	**0.09**
CD (5%)		**2.67**	**2.44**	**2.03**	**1.38**	**0.84**	**0.18**	**0.16**	**0.66**	**0.28**	**0.20**
CV		**7.26**	**7.60**	**4.09**	**7.03**	**2.86**	**3.62**	**7.69**	**7.69**	**1.09**	**1.01**

followed by T_1 (11.53). The results observed are also in agreement with that obtained by Shaheen (1995), Weisman et al. (2002) and Hassan (2000) who found great increase in fruit oil content of olive trees due to boron treatments. Moreover, Kamal (2002) found that boron and Zinc with a combination of GA_3 applications increased the oil percentage in olive fruits.

TSS of fruit showed that there were significant differences among the treatments. Maximum TSS of fruit (13.80) was recorded under the treatment T_{10} followed by T_5 (13.37), T_9 (GA3 @ 150 ppm) (12.90) respectively. Minimum TSS of fruit (10.10) was recorded under the treatment T_0 (control) followed by T_1 (10.60), T_2 (10.90) respectively. The combination of micronutrients and plant growth regulators have shown positive affect on the TSS of olive fruit. The maximum TSS have shown was 13.80 in the treatment T_{10} The studies pertaining to bio-chemical status of fruits reflected that TSS (%) was affected significantly by the micronutrients or the plant growth regulators in the finding of Rajkumar et al. (2014).

4. CONCLUSION

On the basis of the present investigation, it is concluded that among the various treatments applied to enhance the Flowering, Fruit set, fruit Yield, Fruit quality and Oil quality of Olive cultivars, treatment T_{10} (Boron @ 150 ppm + Zinc @ ppm + NAA@ 150 ppm + GA3 @ 150 ppm) was found to be superior among others, followed by treatment T_5 (Boron @ 100ppm + Zinc @ 100 ppm + NAA @ 100ppm + GA3 @ 100ppm) and treatment T_0 (control) was found to be inferior. It is also concluded that among all cultivars, Arbequina cultivar was found best. Thus, treatment T_{10} (Boron @ 150 ppm + Zinc @ ppm + NAA@ 150 ppm + GA3 @ 150 ppm) with Arbequina cultivar is best recommended for overall flowering and fruiting characters of Olive like, Days to flowering, Number of flowers per panicle, Fruit drop percentage, Fruit diameter, Fruit length, Fruit weight, Fruit yield per tree, Fruit yield per hectare, Oil content, TSS of fruit.

ACKNOWLEDGEMENT

The author is thankful to the Advisor and Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology And sciences, Prayagraj (U.P.) India for providing necessary facilities to undertake this research. This manuscript has not received any grant from any sources.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. AOAC. Association of Official Agricultural Chemists. Official methods of analysis. 12th ed, P.O. Washington, DC: Benjamin Franklin Station. 1975;832. Box 450. 6. Kates M. Techniques of lipidology, isolation, analysis and identification of lipids. Amsterdam, London: North-Holland Publishing Company; 1972.
2. AOAC. Official methods of analysis: Association of Official Analytical Chemists. 15th (Ed). Washington, DC; 2000.
3. AOCS. American Oil Chemists' Society official and tentative methods. 2nd ed. The Society. Chicago; 1964.
4. Badal DS, Tripathi VK. Influence of foliar feeding of NAA and boron on growth, flowering, fruiting, and yield of winter season guava (*Psidium guajava* L.) cv. L–49 – An International Journal. 2021;13(3):387-91.
5. Genaidy EAE, Abd-Alhamid N, Hassan HSA, Hassan AM, Hagagg LF. Effect of foliar application of boron trioxide and zinc oxide nanoparticles on leaves chemical composition, yield and fruit quality of Olea europaea L. cv. Picual. Bull Natl Res Cent. 2020;44(1):106.
6. Barone E, La Mantia M, Marchese A, Marra FP. Improvement in yield and fruit size and quality of the main Italian table olive cultivar Nocellara del Belice. Sci Agric. 2014;71(1):52-7.
7. Fageria NK, Baligar VC, Zobel RW. Yield, nutrient uptake, and soil chemical properties as influenced by liming and boron application in common bean in a no-tillage system. Commun Soil Sci Plant Anal. 2007;38(11-12):1637-53.

8. Ferreira IQ, Rodrigues MÂ, Arrobas M. Soil and foliar applied boron in Olive: Tree crop growth and yield, and boron remobilization within plant tissues. Span J Agric Res. 2019;17(1):e0901.
9. Sahu C, Sahu DK. Effect of plant growth regulators on yield and yield attributing characteristics of mango (Mangifera indica L) cv. Dashehari. Int J Hortic Food Sci. 2020;2(1):52-4.
10. Desouky IM, Haggag LF, El-Migeed A, Kishk YFM, El-Hady. Effect of boron and calcium nutrients sprays on fruit set, oil content and oil quality of some Olive Cultivars. World J Agric Sci. 2006;5(2):180-5.
11. Draie DR, Alhaj-Rabie DW, AL-Mahmoud A. Influence of foliar spraying with macro and microelements on the growth and productivity of olive trees in Idleb Province. IRJIET. 2020;04(4):12-24.
12. Mikhail EG, Goargios KG. Effect of calcium nitrate and gibberellic acid Foliar Sprays on Fruiting and Fruit Quality of ”Manzanillo” and ”Dolce” Olive Cvs. Egypt J Hortic. 2014;41(2):169-82.
13. El-Khawaga AS. Effect of girdling and foliar application of some nutrients on growth, flowering, yield and fruit quality of Manzanillo olive trees grown in sandy soil. J Agric Sci 28(3). 2003:2124.
14. Hegazi ES, El-Motaium RA, Yehia TA, Hashim ME. Effect of boron foliar application on olive (*Olea europea* L.) trees 1- vegetative growth, flowering, fruit set, yield and fruit quality. J Hortic Sci Ornamental Plants. 2015;7(1):48-55.
15. Muengkaew R, Chaiprasart P, Wongsawad P. Calcium, boron addition promotes pollen germination and fruit set in mango. Int J Fruit Sci; 2002.
16. Sajid M, Abdur-Rab NA, Arif M, Ferguson L, Ahmed M. Effect of foliar application of zinc and boron on fruit production and physiological disorders in sweet orange cv. blood orange. Sarhad J Agric. 2010;26(3):355-60.
17. Ali M, Ahmad M, Naveed Anjam, Hafeez-ur-Rehman M, Imran Kasana, Sudheer Tariq, Aasia ramzan. efficacy of boron & gibberellic acid on growth and fruit yield in olive (*Olea europaea* L.) cv. Gemlik Int J Biol Biotechnol. 2014;11(2-3):295-8.
18. Ahmad M, Khan MA, Hafeez-Ur-Rahman NA, Tariq S, Ramzan A. Uslu. Int J Biol Biotechnol. 2011 effect of boron and gibberellic acid on growth and fruit yield of Olive cv. 8(1):123-6.
19. Osama HM, Gammal E. Effect of zinc and boron on yield and fruit quality of Manzanillo Olive trees under Siwa Oasis conditions, Alexandria Science Exchange. Journal. 2022;4.
20. Singh A, Upadhyay S, Upadhyay RG. Effect of plant growth regulators (NAA, 2,4-D and GA3) on Fruit Retention and Quality of Mango cv. Dasehri. Int J Trop Agric. 2017;35(4):967-74.
21. Bonyanpour AR, Moafpourian GR, Jamali B. Responses of ”Belidi” Olives to foliar and soil applied iron, manganese and zinc fertilizers. J Appl Hortic. 2017;19(2):125-9.
22. Askarieh A, Suleiman S, Tawakalna M. Sweet cherry (*Prunus avium* L.) fruit drop reduction by plant growth regulators (naphthalene acetic acid NAA and gibberellic acid GA3). Am J Plant Sci. 2021;12(9):1338-46.
23. Sayyad-Amin P, Shahsavar AR, Aslmoshtaghi E. Study on foliar application nitrogen, boron and zinc on olive tree. Trakia J Sci. 2015;13(2):131-6.
24. Devi P, Gautam RKS, Singh J, Maurya SK, Chaudhary A. Effect of foliar application of NAA, GA3 and zinc sulphate on fruit drop, growth and yield of ber (*Zizyphus mauritiana* Lamk.) cv. Banarasi Karaka. Int J Curr Microbiol Appl Sci. 2019;8(1):1679-83.
25. Sharma R, Tiwari R. Effect of growth regulator sprays on growth, yield and quality of guava under malwa plateau conditions. Annals Plant Soil Res. 2015;17(3):287-91.
26. Abou El-Wafa M, Ali AAM, El Barbary MG. Productivity of olive trees as influenced by spraying with glucose, phosphorus and gibberellic acid. Am Eurasian J Agric Environ Sci. 2021;21(2):117-25.
27. Abo-El-Ez AET, Shaheen SA, Abo-Eloun HM. Effect of foliar application some plant growth regulators on growth and productivity of olive trees under South Egypt conditions. J Plant Prod. 2018;9(10):775-83.
28. Abdrabboh GA. Effect of Some growth regulators on yield and fruit quality of Manzanillo Olive trees. Nat Sci. 2013; 11(10):143-51.
29. Wiesman Z, Ronen A A, Ankarion Y. Maranz S, Chpagain B and Abramovich Z. Acta Hortic. Effect of Olive-Nutri-vant on

yield and quality of Olives and oil. 2002; 594:557-62.

30. Jagtap VM, Patel HC, Nehete DS, Godage SS. Effect of foliar application of plant growth regulators and micronutrients on yield and quality of acid lime cv. KAGZI (*Citrus aurantifolia* Swingle). Asian J Hortic. 2013;8(1):57-9.
31. Abd El-Naby SKM, El-Sonbaty MR, Hegazi ES, Samira MM, El-Sharony TF. Effect of gibberellic acid spraying on alternate bearing of olive trees. J Appl Sci Res. 2012;8(10):5114-23.
32. Gill PPS, Bal JS. Effect of growth regulator and nutrients spray on control of fruit drop, fruit size and quality of Ber under sub-montane zone of Punjab. J Hortic Sci. 2009;4(2):161-3.
33. Samira MM, TF, El-Sharony. Effect of gibberellic acid spraying on alternate bearing of olive trees. J Appl Sci Res. 2012;8(10):5114-23.
34. McLaughlin SB, Wimmer R. Tansley Review No. 104. New Phytol. 1999;142(3):373-417.
35. Hasani M, Zamani Z, Savaghebi G, Fatahi R. Effects of zinc and manganese as foliar spray on pomegranate yield, fruit quality and leaf minerals. J Soil Sci Plant Nutr. 2012;12(ahead):471-80.
36. Suman M, Sangma PD, Meghawal DR, Sahu OP. Effect of plant growth regulators on fruit crops. J Pharmacogn Phytochem. 2017;6(2):331-7.
37. Sourour MSM, Abd EEK Ella, Wafaa A El-Sisy. Growth and productivity of olive tree as influenced by foliar spray of some micronutrients, Journal of Agriculture and Environmental Science. Egypt: Alex University. 2011;102.
38. Laila F, Hagagg MMM, Abd El-Migeed A, MF, Shahin MFM, Merwad MA, et al. Impact of foliar application of zinc sulphate and gibberlic acid on fruit quality and quantity of ”Kalamata” olives. Middle East J Agric Res. 2014;3(4):745-50.
39. Lewis DH. Are there interrelations between metabolic role of boron, synthesis of phenolic phytoalexin and the germination of pollen? New Phytol. 1980;84(2):261-70.
40. Ghosh SN, Bera B, Roy S, Kundu A, Roy SKD. Effect of nutrients and plant growth regulators on fruit retention, yield and physio-chemical characteristics in Aonla cv. NA-10. J Hortic Sci. 2009;4(2):164-6.
41. Saadati S, Moallemi N, Mortazavi SMH, Seyyednejad SM. Foliar applications of zinc and boron on fruit set and some fruit quality of olive. Vegetos. 2016;29(2):2.
42. Sabour AMT. Influence of calcium and zinc on controlling the inflorescence malformation and improving fruiting of Hindy bisinnara mango trees. J Agric Sci Mansoura Univ. 2001;26(4):2263-9.
43. Ramezani S, Shekafandeh A. Roles of gibberellic acid and zinc sulphate in increasing size and weight of Olive fruit. Afr J Biotechnol. 2009;8(24):6791-4.
44. Ramezani S, Shekafandeh A, Taslimpour MR. Effect of GA3 and zinc sulphate on fruit yield and oil percentage of ”Shengeh” olive trees. Int J Fruit Sci. 2010;10(3): 228-34.
45. Sayyad-Amin AR, Shahsavar E Aslmoshtagh. Trakia J Sci. Study on foliar application nitrogen, boron and zinc on Olive tree. 2015;2:131-6.
46. Nafea SM, Abdulfatah HK. 2014 effect of Foliar application of GA3 and NAA for reducing alternate bearing of Olive trees (*Olea europaea* L. cv. Ashrasie) Journal of Agriculture and Veterinary Science;7(1):08-12.
47. Shaheen SAA. Effect of foliar sprays of some nutrients on flowering and fruiting of Olive trees [M.Sc. thesis]. Faculty of Agriculture., Cairo Univ. p. 122; 1995.
48. Sheikh KHA, Singh B, Haokip SW, Kripa S, Debbarma R, Athokpam GD et al. Response of yield and fruit quality to foliar application of micronutrients in lemon [*Citrus limon* (L.) Burm.] cv. Assam Lemon. J Hortic Sci. 2021;16(2):144-51.
49. Singh G, Bons HK. Influence of naphthalene acetic acid on fruit setting, fruit quality and yield of Manilkara achras L. cv. Kalipatti under subtropical conditions. Indian J Exp Biol. 2020;58:661-6.
50. Dar GA. Impact of Boron Nutrition in Fruit crops. Int J Curr Microbiol Appl Sci. 2017;6(12):4145-55.
51. Hamdy HA, Khalifa SM, Hamdy AE, Abd El-Wahed AN. Effect of GA3 and NAA on growth, yield and fruit quality of Washington navel orange. Egypt J Hortic. 2017;44(1):33-43.
52. Haggag LF, Abd El-Migeed MMM, Fawzi MIF, Shahin MFM, Merwad MA. Influence of spraying zinc sulphate and Gibberlic acid on yield and fruit properties of ”Manzanillo” Olives. Int J Agric Technol. 2015;11(7):1599-611.

53. Harhash MM, Nasr Alla WME, Mosa WFA. Response of "Kalamata" olive cultivar to the foliar application of Moringa extract, boron, and zinc. Egypt Acad J Biol Sci. 2022;13(2):171-8.
54. Hassan HSA, Sarrwy SMA, Mostafa EAM. Effect of foliar spraying with liquid organic fertilizer, some micronutrients and gibberellins on leaf minerals content, fruit set, yield, and fruit quality of "Hollywood" plum trees. Agric Biol J North Am. 2010;1:638-43.
55. Bonyanpour AR, Moafpourian GR, Jamali B. Responses of "Belidi" Olives to foliar and soil applied iron, manganese and zinc fertilizers. J Appl Hortic. 2017;19(2):125-9.
56. Shereen A, Abo-Eloun HM 2018. Effect of foliar application some plant growth regulators on growth and productivity of olive trees under South Egypt conditions. Journal of plant production. Mansoura University, 9(10): 775-83.
57. Singh A, Singh HK. Application of plant growth regulators to improve fruit yield and quality in indian gooseberry (*Emblica officinalis* Gaertn.). J AgricSearch. 2015; 2(1):20-3.
58. Perica S, Brown PH, Connell JH, Nyomora AMS, Dordas C, Hu H, et al. Foliar boron application Improves flower fertility and fruit set of Olive. Hortscience. 2001; 36(4):714-6.
59. Yadav S, Singh JP, Gupta S, Yadav JS. A study on foliar feeding of GA3 and NAA on fruit drop, retention, yield and quality of Ber Fruit (*Ziziphus mauritiana* Lamk.). "Banarasi Karaka" Biological Forum – An International Journal. 2021;13(3):608-12.
60. Talaie A, Badmahmoud MT, Malakout MJ. The effect of foliar application of N, B and Zn on quantitative and qualitative characteristics of olive fruit. Iran J Agric Sci. 2001;32:727-36.Vegetos 29:2.
61. Yadav DK, Meena YK, Deewan P, Gupta D. Effect of foliar application of micronutrients on yield and quality of pomegranate. Int J Bio-Resource Stress Manag. 2022;13(9):914-20.
62. Singh Y, Thakur N, Meena NK. Studies on the effect of foliar spray of Zn, Cu and B on growth, yield and fruit quality of sweet orange (*Citrus sinensis* L.) cv. mosambi. Int J Chem Stud. 2018;6(5):3260-4.
63. Rajkumar JPT, Shant Lal. Effect of foliar application of zinc and boron on fruit yield and quality of winter season guava (*Psidium guajava*) cv. pant Prabhat Annals of Agri. Biol Res. 2014;19(1):105-8.
64. Khalil F, Qureshi KM. Ammaz Khan, Fakhar-ul-Hassan and Nabila Bibi 2012 effect of girdling and plant growth regulators on productivity in olive (*Olea europaea*) Pakistan Journal of Agricultural Research; 25(2).

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/104827