Improving vegetative growth of transplants of two olive cultivars by foliar application of some organic extracts and chemical fertilizers

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ABSTRACT

This study investigated the effects of foliar spraying with NPK, organic fertilizers, and seaweed extract on 2-month-old seedlings of Coratina and Aggizi Shame olive cultivars, to improve vegetative growth and reduce the tending time of transplants in the nursery. Growth parameters, minerals and photosynthetic pigment contents were measured. The trials were carried out in greenhouse of Horticulture Research Institute (HRI) during 2020/2021 and 2021/2022 seasons. The experiment was arranged using a completely randomized design. The results on the response of Coratina transplants to spraying NPK alone indicated significantly increases in the plant height and root length of transplants. However, the foliar application with compost tea (CT) + NPK increased the contents of chlorophyll-a and total carbohydrates. Treating cv. Coratina with foliar application of seaweed (SWE) combined with NPK greatly enhanced the root length and increased the number of lateral branches/plant as well as the contents of N, P, chlorophyll-b, and carotenoids. Furthermore, Aggizi Shame olive transplants which received a foliar application with vermicompost tea (VCT) + NPK showed the tallest transplants and the longest roots. However, the treatment of SWE+NPK achieved the highest number of lateral branches/transplant, and the highest contents of K, chlorophyll-a,-b and carbohydrate in the leaves of the two olive cvs. (Coratina and Aggizi Shame). The present investigation proved that either SWE or VCT in combination with NPK could be used as a foliar application for improving the growth of olive transplants successfully.

Keywords: Olive- Compost tea - Vermicompost tea- Seaweed extract- Vegetative growth and chemical constituents.

INTRODUCTION

The olive tree (*Olea europaea* L. family Oleaceae) is an evergreen long-lived tree; it is an economically important fruit tree because of its fruit and oil. It is one of the oldest cultivated trees, and is widely distributed in many areas of the world. The Mediterranean region is its native habitat. Olive is adapted to extremely conditions, can thrive and produce in new reclaimed areas where other crops can't grow. Olive areas are increased rapidly in Egypt, it is capable of persisting in most the negative effect of drought and salinity. The olive tree is perennial evergreen tree has great socioeconomic importance for many countries (Arenas-Castro *et al*., 2020 and Langgut et al., 2019). Olive trees cover approximately 10.5 million hectares worldwide (FAOSTAT, 2020). Due to the climatic requirements of olive trees, around 95% of the total area is cultivated in the Mediterranean basin concentrate (Rediam, 2020).

Olive seedlings are characterized by slow growth in nurseries compared to other fruit transplants. This requires their stay for a longer period in the nurseries in order to be ready for cultivation in the sustainable place. Thereupon, they need nourishment to enhance their growth by spraying with minerals and organic fertilizers that ensure prompt delivery of many essential elements, in a form that can be absorbed by the leaves, especially in the early stages of transplant life (Hassan, 2017). Nowadays, many advanced countries are changing their policies of agriculture to reduce or ban chemical products (Adnan & Anjum, 2021).

The applications of fertilizers can be done to crops by soil and foliar yet foliar application is simple and affordable and environment friendly (Toor et al., 2020and Adnan et al., 2020). Some authors have reported the use of foliar fertilization and bio stimulants on olive trees improved vegetative growth characteristics (Mahmoud *et al*., 2017; Zouari et al., 2021). Intensified olive orchard management involves higher use of fertilizers, particularly nitrogen, phosphorus, and potassium. While nutrient deficiencies can hinder production, over-fertilization may decrease yields and oil quality, and lead to environmental issues and higher production costs (Carranca et al., 2018 and Zipori et al., 2020).

Therefore, significant attention has been directed toward alternative fertilizers, including bio-fertilizers, in the Middle East. Combining bio-fertilizers with NPK fertilizers is seen as an optimal approach to reduce chemical fertilizer use while sustaining soil health with minimal negative impacts. (Palm et al., 2001). Bio-fertilizers are considered as eco-friendly way to sustainable agriculture. They positively affect plant growth and yield, reduce the negative effects of chemical fertilizers and minimize. Organic matter (e.g., manure, compost) and cover crops are widely used as substitutes for mineral fertilizers, offering added benefits to soil properties that can enhance the sustainability of olive orchards (Zipori et al., 2020). Shaban and Nasab, (2015) sated that compost tea is used for its beneficial effect on plants, and high quality compost tea contains high microbiological activity, and dilution of the tea prior to foliar application may reduce the nutrients and microbial population. On the other side, According to Zaccardelli et al. (2018), compost tea is an organic liquid derived from extracting water through quality compost. It contains beneficial microorganisms and compounds that help protect and enhance plant growth. Additionally, compost tea includes essential nutrients that can correct deficiencies during crop production and has been shown to hold bioactive concentrations of compost-derived compounds. Vermicompost technology is a biotechnological process of converting organic waste into compost using specialized earthworms (Fudzagbo and Abdulraheem, 2020). Vermicompost usage can be avowable in term of both increasing production material quality and development of saplings in olive sapling nursery (Hatice et al., 2020). Seaweeds are considered a natural resource of bio-elicitors because of their high polysaccharide content. Plants sprayed with it are characterized by higher resistance to frost, drought, heat, water stresses and plant protection from aging. Also, it enhances plant resistance to many diseases; contribute to the recovery of damages caused by insects and bacterial or fungal diseases and nematode infestation (Sangha et al., 2015; Shukla et al., 2018). Foliar spraying with seaweed extract at levels 6 $ml.L^{-1}$ gave the largest leaf area and leaves dry weight of Ashrasi" olive transplant (Al-Hadethi, 2019). It is advised to use a growth medium of silt, farmyard manure, and NPK to produce high-quality olive transplants, improving factors such as the number of primary branches, root length, fresh root weight, and chlorophyll content (Saad et al., 2021). The olive transplants are usually needed about a year in the nursery under tending operation for best growth that costs a lot of money and time. Growing high quality olive transplants helps to a strong start in the field. In our study, we tried to shorten the time of tending operation of transplants of two olive cvs. and increase their growth rates using different types of fertilizers to get a better result and reduce the tending period in the nursery. During the nursery care of olive transplants, it is essential to ensure they are healthy (free from diseases and insects), vigorous, with a straight trunk, smooth texture, and clean bark. They should have a diameter of 0.6-1 cm and a well-developed root system, all requiring careful attention. Therefore, this study aimed to investigate the effects of organic extracts (compost tea, vermicompost tea, and seaweed extract), either alone or combined with NPK chemical fertilizer, on the vegetative growth and quality of transplants for two olive cultivars (Coratina and Aggizi Shame).

MATERIALS AND METHODS

Plant materials:

This experiment was conducted under greenhouse the Horticultural Research Institute, ARC, Giza- Egypt, from March to September, during two successive seasons 2020/2021 and 2021/2022. It was amid to study the effect of foliar application of NPK (20, 20, 20) and organic fertilizers (compost tea, vermicompost tea and seaweed extract) on vegetative growth and some chemical constituents of transplants of two olive cultivars (Coratina and Aggizi Shame). Coratina is foreign olive oil cultivar and Aggizi Shame is Egyptian olive table cultivar. Both of them was obtained by leaf cuttings propagation under mist system. Healthy and almost uniform transplants (14-15 cm plant height , 8-10 leaves) which produced under mist propagation system, were selected and planted in black polyethylene bags (30cm diameter) filled with mixture of vermiculite, peat moss (1:1 ,v/v) and amended with 25% compost. After planting, the transplants were irrigated twice a week. The olive transplants were irrigated with the same amount of water and were subjected to the standard recommended cultural practices.

The experimental treatments layout:

Under greenhouse conditions, the two olive cultivars were subjected to the following treatments:

1- Control (non-treated transplants),
2- NPK at 2g L^{-1}
3- Compost tea (10%)
4- Compost tea (10%) +NPK at 2g L^{-1}
5- Vermicompost tea (10%)
6- Vermicompost tea (10%) + NPK at 2g L^{-1}
7- Seaweed extract at 2 ml L^{-1}
8- Seaweed extract at 2 ml L^{-1} + NPK at 2g L^{-1}.

The compost and vermicompost were extracted with tepid water for 72 hours before use (1:10W/V) in non-degradable polyethylene containers with a cover, as according to the method described by (Siddiqui et al., 2008). Aeration was provided using an aquarium pump, and the mixes were left at room temperature for 48 hours. The completed liquid was foliar sprayed after being strained through two thicknesses of cheesecloth.

The vermicompost extracts, watery compost and NPK were administered once a week. The Soil, Water, and Environmental Research Institute at the Agricultural Research Centre determined the chemical composition of the irrigation water, as well as the physical and chemical properties of the compost, vermicompost, compost tea, vermicompost tea, and seaweed extract water. The analyses were conducted using methods described by Jackson (1973) and are summarized in **Tables (1, 2, 3, and 4)** Locally produced compost and vermicompost were placed in a barrel, which was then topped off with water

Table 1. Physical and chemical properties of water.

pH 2.5:1	Soluble cations (me/L)			
7.12	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
E.C. ds/M (1:5	1.80	0.70	2.50	0.20
1.406	Soluble anions (me/ L)			
S.A.R	CO_3-	HCO_3^-	Cl^-	SO_4^-
2.23	-	0.29	4.51	0.40

Table 2. Physical and chemical properties of the compost and vermicompost:

Character	Compost	Vermicompost
Physical properties		
Bulk density kg/m^3	780	1070
Moisture content %	14	20
Chemical properties		
pH	8.30	8.50
EC (ds/ m)	2.45	0.85
Organic matter %	31.50	50.90
Organic carbon %	18.00	29.50
Ash %	68.00	42.00
Total nitrogen %	1.22	1.90
C: N ratio	15:01	14:01
Total phosphorus %	0.65	0.95
Total potassium %	0.85	1.21

Table 3. Chemical analysis for compost tea and vermicompost tea:

Characters	Vermicompost tea	Compost tea
Ph	7.20	7.61
EC (ds/ m)	1.85	1.90
Organic matter %	4.85	5.35
Organic carbon %	2.20	3.15
Total N %	0.45	0.18
Total P %	0.10	0.90
Total K %	0.08	0.06

Chemical analysis: During August each season, samples consisting of twenty leaves per replicate were collected from the middle part of terminal sprouted shoots. The leaf samples were washed, air-dried at 70°C until reaching a constant weight, and then ground. The dried leaf samples were digested using sulfuric acid and hydrogen peroxide, as described by Evenhuis and Dewaard (1980).

The nitrogen (N) and phosphorus (P) percentages in the dried leaves were determined colorimetrically using the methods outlined by Bremner and Mulvaney (1982) and Olsen and Sommers (1982), respectively. The potassium (K) percentage was measured using a flame photometer, following the procedure described by Jackson (1973).

Leaf photosynthetic pigments content: Leaf samples consisting of ten leaves were taken during August from the middle of terminal sprouted shoots/replicate for determining chlorophyll content (A, B and carotene) according to the method mentioned by (Saric et al., 1967). Total carbohydrates: were determined (Gul and Safdar, 2009).

Table (4). Physical and chemical analysis for seaweed extract:

Physical properties		Components	
State	Liquid	**Protein**	0.20%
Solubility	99%	**Carbo-hydrates**	1.20%
pH	4.60	**Ashes**	2.60%
Boiling point	100 C	**Moisture**	96%
Growth Stimulant Activity		**Amino acids (mg/ 100g)**	
Auxin-like biological activity	10.70 mg	**Alanine**	150 mg
Cytokinin-like biological activity	0.03 mg	**Proline**	92 mg
Macro/Micro nutrients		**Lysine**	80 mg
Nitrogen	0.30%	**Leucine**	72 mg
Phosphorus	0.75%	**Glycine**	70 mg
Potassium	0.45%	**Valine**	70 mg
Sodium	0.11%	**Phenyl-alanine**	60 mg
Calcium	0.01%	**Arginine**	48 mg
Boron	3.2 mg	**Glutamic acid**	35 mg
Copper	1.8 mg	**Aspartic acid**	31 mg
Iron	**Magnesium**	**Manganese**	**Zinc**
1.2 mg	**56.40 mg**	**0.80 mg**	0.90 mg

Statistical analysis:

The experiments were conducted using a Completely Randomized Design (CRD). The data were analyzed using the F-test and analysis of variance (ANOVA) according to Snedecor and Cochran (1990). Differences between treatments were assessed with Duncan's Multiple Range Test at a 5% probability level (Duncan, 1955).

RESULTS AND DISCUSSION

Effect of foliar spraying with NPK and compost, vermicompost teas and seaweed extracts on some vegetative growth parameters of two cultivars olive transplants (Coratina and Aggizi Shame)

Plant height (cm):

Statistical analysis of data **(Table 5)** revealed that, the tallest plants of cv. Coratina at the end of experiment was recorded with the foliar treatment of vermicompost tea either or in combination with NPK treatment (49 and 50 cm) in first season only. Meanwhile, in the second one, NPK was the best treatment (82.33 cm).

Conversely, the lowest plant height was recorded in the non-treated transplants (control treatment), measuring 29 cm and 53 cm in the first and second seasons, respectively.

According to data presented in **(Fig.1),** all treatments increased plant height of cv. Aggizi Shame transplants significantly more than the control, in the first season. Whereas, NPK+CT and NPK + VCT treatments gave the highest values (42.67 and 89 cm) in second one, respectively. On the other hand, the lowest values were recorded in untreated plants, with measurements of 27.33 cm and 49 cm in both seasons, respectively.

Root length (cm):

Table (5) shows that treatments with NPK alone or in combination with seaweed extract applied as a foliar application significantly increased root length in cv. Coratina transplants, with root lengths of 20.33 cm and 29 cm for NPK, and 20.33 cm and 29.33 cm for NPK + Seaweed in both seasons. In contrast, the control treatment produced the lowest values, at 14 cm and 20.67 cm in both seasons. As show in (Fig. 2), all treatments increased the root length of olive Aggizi shame transplants in comparison with control. Despite the fact that NPK+VCT increase root length in both seasons (28 and 24.33 cm), respectively.

Table (5). Effects of foliar spraying with NPK and compost, vermicompost and seaweed extracts on some vegetative growth parameters (plant height root length, leaf surface area and No. of lateral branches/plant) of Coratina olive transplants in 2020/2021 and 2021/2022 seasons.

Treatments	Plant height (cm)		Root length (cm)		Leaf area (cm^2)		No. of lateral branches	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	29.00^{c}	53.00^{e}	14.00^{cd}	20.67^{bc}	3.88^{b}	5.50^{f}	3.33^{b}	6.33^{b}
NPK	25.67^{c}	82.33^{a}	20.33^{a}	29.00^{a}	3.91^{b}	7.44^{ab}	4.00^{ab}	5.33^{b}
CT*	39.000^{b}	62.33^{cd}	19.33^{ab}	18.67^{c}	4.75^{ab}	6.33^{d}	3.67^{ab}	7.00^{ab}
NPK+CT	45.67^{ab}	76.33^{b}	16.33^{bc}	27.67^{ab}	5.43^{a}	7.46^{a}	6.00^{a}	8.00^{a}
VCT**	49.00^{a}	72.33^{bc}	12.00^{d}	23.33^{b}	4.98^{a}	5.75^{ef}	5.33^{ab}	9.00^{a}
NPK+VCT	50.00^{a}	80.33^{ab}	17.33^{b}	24.33^{b}	5.13^{a}	6.93^{c}	5.00^{ab}	7.67^{a}
SWE***	42.00^{ab}	65.33^{c}	19.33^{ab}	27.33^{ab}	5.19^{a}	6.2^{de}	4.33^{ab}	7.33^{ab}
NPK+SWE	46.00^{ab}	60.00^{d}	20.33^{a}	29.33^{a}	4.94^{a}	6.99^{bc}	5.00^{ab}	8.67^{a}
LSD at 0.05	9.29	9.18	8.39	3.85	0.9	0.47	2.55	3.86

Means in each season with the same letter are not significantly different at the 5% level, as determined by Duncan's Multiple Range Test.*CT=Compost tea, **VCT= Vermicompost tea, ***SWE= Seaweed extract.

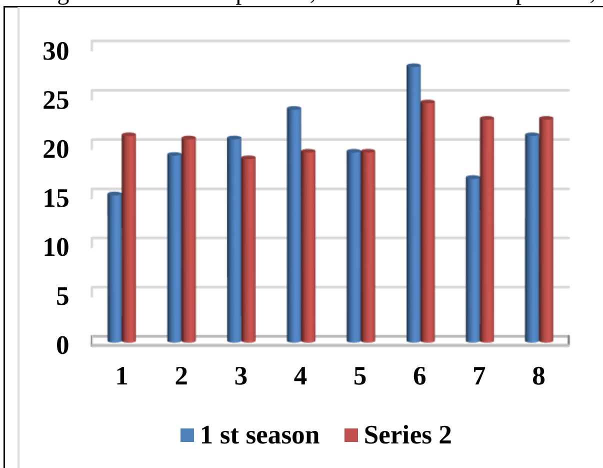

Fig.1- Plant height (cm) cv. Aggizi Shame

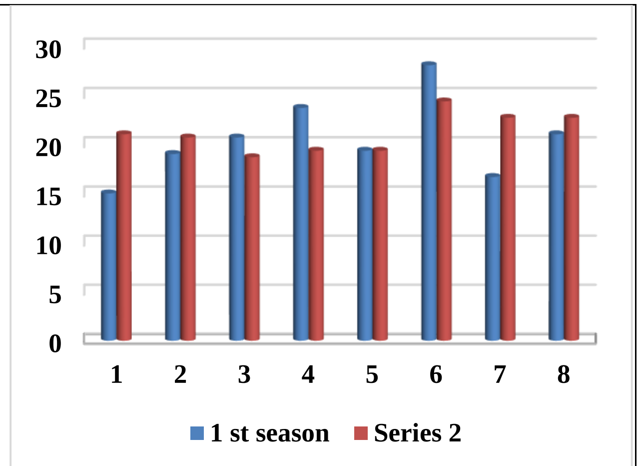

Fig.2- Root length (cm) cv. Aggizi Shame

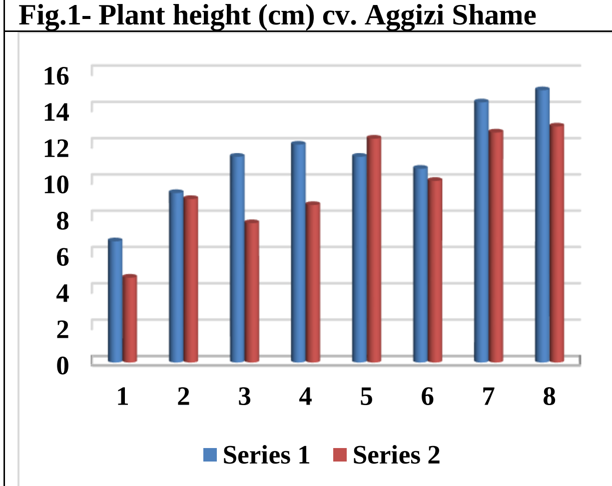

Fig.3- Leaf surface area cv. Aggizi Shame

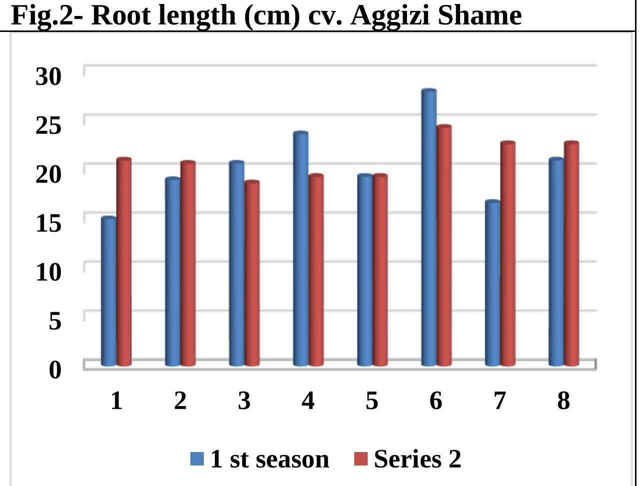

Fig.4- No. of lateral shoots cv. Aggizi Shame

1-Control. 2-NPK at 2g L^{-1}. 3-Compost tea. 4-Compost tea + NPK at 2g L^{-1}. 5- Vermicompost tea. 6-Vermicompost tea + NPK at 2g L^{-1}. 7- Seaweed extract and 8-Seaweed extract + NPK at 2g L^{-1}.

Leaf surface area (cm^2):

The effect of the tested treatments on the leaf surface area (cm²) of olive Coratina transplants is illustrated in Table 5. Statistically the maximum values (5.43 and 7.46 cm^2) were recorded by NPK + compost tea in both seasons, respectively. Conversely, the lowest leaf surface area records were 3.88 cm² and 5.5 cm² in the first and second seasons, respectively, for the control treatment. Data on the effect of the tested treatments on the leaf surface area (cm²) of olive Aggizi Shame transplants are illustrated in Fig. 3. Statistically the maximum leaf areas (3.43 and 6.85 cm2) were recorded by NPK treatment in both seasons, respectively. Reversely, the minimum records (2.64 and 4.7 cm^2) in first and second seasons with autogenic control treatment, respectively.

No. of lateral branches/plant:

The data presented in **Table (5)** show that NPK + CT foliar applications produced the highest number of lateral branches per plant in olive transplants, compared to other treatments, but this effect was observed only in the first season. Meanwhile, there is no significant differences between following treatment (NPK+CT, VCT, NPK+VCT and NPK+SWE) gave the best value in second season. It is worthy to mention in **(Fig.4)** that Aggizi Shame olive transplants treated by NPK+SWE produced the maximum number of lateral branches/plant (15 and 13) in both seasons. Followed by SWE alone in both seasons (14.33 and 12.67). In the contrast, untreated treatment had the lowest value of no. lateral branches/plant (6.67 and 4.67).

The results are agreement with those obtained by (Ismael and Gray, 2012, Ibrahim, 2013 and Al-Hadethi, 2019) who confirmed that, the foliar sprayed with seaweed extract gave the highest leaf area, shoot length, shoot number and leaves dry weight of olive transplants. This results from the influence of these extracts on cell metabolism by inducing the synthesis of antioxidant molecules, which can enhance plant growth. Also, Hosseinzadeh et al. (2016) and Amiri et al. (2017) on chickpea who confirmed that, vermicompost tea were the most effective treatment on growth parameters, reproductive development. Indeed, plant height increased. This growth stimulation may be due to water-soluble bioactive molecules in vermicompost, such as phytohormones, humic and fulvic acids, minerals, amino acids, and microbial metabolites.

Effect of foliar spray with NPK and compost, vermicompost teas and seaweed extracts on some leaf mineral contents (N, P and K) of two olive transplants (Coratina and Aggizi Shame) cvs:

Nitrogen %: Data in **Table (6)** show that the tested materials used as foliar sprays significantly increased the nitrogen (N) percentage in Coratina olive transplants. The NPK + VCT treatment enhanced N% to 2.47% in the first season only, while the NPK + SWE treatment increased N% to 2.63% in the 2021 season. Concerning leaves content of microelements, the highest significant N values of Aggizi Shame cv. **(Table 7)** were obtained by transplants treated with foliar spraying of NPK+VCT (2.05 and 3.5 %) in 2020/2021 and 2021/2022, consecutively.

Phosphorous %

Regarding phosphorus (P%) content, results in Table 6 indicate that the P% in cv. Coratina olive leaves was significantly influenced by the different treatments in both seasons. The NPK + SWE treatment yielded the highest P% values, with 0.26% in the first season and 0.37% in the second season. Followed by NPK+VCT (0.38 P %) in second season only. Reversely, leaf P content decreased to the minimum values (0.13 and 0.14%) with control treatment (untreated), this was true in both studied seasons.

Data concerning this factor of study was discussed for statistical analysis and the results obtained are given in **(Table 7)** and a perusal of given table indicated highly significant results. Results showed that plant which sprayed with NPK+VCT solution represent the significant P% (0.45 and 0.32%) in both seasons, respectively. Followed by NPK treatment (0.42%) in first season only and NPK+SWE treatment (0.31%) in second season only, as compared to remaining treatments.

Table (6). Effects of foliar spraying with NPK and compost, vermicompost teas and seaweed extracts on some leaf mineral content (N, P and K) of Coratina olive transplants.

Treatments	N %		P %		K %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	0.80d	2.23b	0.13b	0.14d	0.93b	0.91d
NPK	1.07c	2.24b	0.14b	0.24bc	1.2ab	1.15ab
CT*	0.80d	2.35ab	0.19ab	0.16cd	1.00b	0.92cd
NPK+CT	1.27c	2.35ab	0.17b	0.27b	1.10ab	1.19a
VCT**	2.27ab	2.17b	0.2ab	0.26b	0.19c	1.00b-d
NPK+VCT	2.47a	2.15b	0.17b	0.38a	1.41a	1.18a
SWE***	1.93b	2.12b	0.17b	0.15d	0.99b	1.09a-c
NPK+SWE	1.93b	2.63a	0.26a	0.37a	1.21ab	1.15ab
LSD at 0.05	0.52	0.35	0.08	0.08	0.32	0.17

Means in each season with the same letter are not significantly different at the 5% level, as determined by Duncan's Multiple Range Test.*CT=Compost tea, **VCT= vermicompost tea, ***SWE= Seaweed extract

Table (7). Effects of foliar spraying with NPK and compost, vermicompost and seaweed extracts on some leaf mineral content (N, P and K) of Aggizi Shame olive transplants.

Treatments	N %		P %		K %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	0.90d	2.05b	0.25c	0.12d	0.84d	0.74c
NPK	1.60c	2.61b	0.42a	0.23bc	1.07bc	1.31a
CT*	1.83b	2.22b	0.23c	0.13d	0.92cd	1.21b
NPK+CT	1.98a	2.56b	0.31b	0.25b	1.21ab	1.25ab
VCT**	1.83b	2.53b	0.33b	0.22bc	1.04bc	1.20b
NPK+VCT	2.05a	3.50a	0.45a	0.32a	1.2ab	1.33a
SWE***	1.72bc	2.09b	0.25c	0.21c	1.14ab	1.28ab
NPK+SWE	2.03a	2.51b	0.34b	0.31a	1.28a	1.35a
LSD at 0.05	014	0.75	041	0.04	019	0.21

Means in each season with the same letter are not significantly different at the 5% level, as determined by Duncan's Multiple Range Test.*CT=Compost tea, **VCT= vermicompost tea, ***SWE= Seaweed extract

Potassium % contents:

Concerning leaves content of potassium of Coratina cv. **(Table 6),** the highest significant K values were obtained by NPK+VCT treatment (1.41 and 1.18%) in both seasons, respectively.

Regarding the data of Aggizi Shame cv. **(Table 7)** showed the result fluctuation in K%, application of NPK+SWE as a foliar spraying of Aggizi shame olive plants increases the K% content (1.28 and 1.35%) in both seasons, respectively. Followed by NPK+VCT and NPK alone (1.32 and 1.31) in second season, respectively. On the contrary, control treatment gave the lowest value of K% (0.84 and 0.74%) in both seasons, respectively.

The observed effects on plant nutrient status from spraying different solutions can be attributed to the rapid absorption through leaves and minimal nutrient loss when using NPK in combination with either VCT or SWE. This is consistent with Hagagg et al. (2012), who found that green power (organic fertilization) and NPK significantly increased P and K content in olive leaves of cv. Koroneiki. Similarly, Haggag et al. (2014) and Hussein and Emadeldin (2018) reported that macro-nutrient applications (NPK) raised N, P, and K percentages in Manzanillo olive seedlings compared to controls. Abd-Alhamid et al. (2015) observed increases in leaf mineral content (N, P, K, Fe, Zn, and Mn) with 75% of the recommended MNF dose plus biofertilizers. Osman et al. (2010) also found that bio and NPK fertilizers significantly boosted N, P, and K contents in olive leaves. Furthermore, Othman (2010) noted that the Coronaki cultivar had higher leaf content of N, P, K, Ca, Mg, Fe, Mn, and

Zn compared to the Manzanillo cultivar when fertilized with a combination of kotengin, biofertilizer, and K2SO4. Chouliaras *et al.* (2009) recommended combining NH4NO3, borax, and sea force to improve the nutritional status of Koroneiki olive trees.

Effect of foliar spraying with NPK and compost, vermicompost teas and seaweed extracts on chlorophyll A and B, carotene and carbohydrates of two olive transplants cvs:

Chlorophyll A:

As shown in **(Table 8),** the foliar application of NPK+CT produced significantly increased the chlorophyll A of Coratina transplants (7.45 and 8.38 mg/100g) in both seasons, respectively. Followed by SWE alone or in combination with NPK (7.26 and 7.12 mg/100g) in first season only. In contrast, the lowest values of Chlorophyll A were recorded with untreated plants (4.49 and 1.94 mg/100g).

Table (8). Effects of foliar spraying with NPK and compost, vermicompost teas and seaweed extracts on chlorophyll A, B, carotene and carbohydrate, Coratina olive transplants.

Treatments	Chlorophyll A mg/100g fresh weight		Chlorophyll B mg/100g fresh weight		Carotene mg/100g fresh weight		Carbohydrates mg/100g fresh weight	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	4.49c	1.94d	6.09bc	3.83a	1.77de	1.48c	27.82b	27.37c
NPK	6.27ab	3.67c	5.26c-e	2.46bc	2.5bc	1.48c	27.68b	30.57b
CT*	4.52c	7.74ab	3.60ef	3.16ab	1.65e	1.58c	35.82a	27.67c
NPK+CT	7.45a	8.38a	8.00a	3.13ab	2.06c-e	2.12ab	36.58a	33.2a
VCT**	6.16ab	7.76ab	3.34f	2.49bc	2.35c	1.73bc	29.49b	26.61c
NPK+VCT	5.22bc	6.99ab	3.81d-f	3.07ab	2.25cd	1.79bc	35.13a	31.93ab
SWE***	7.26a	6.64b	5.55b-d	2.05c	2.84ab	2.09ab	29.83b	20.59d
NPK+SWE	7.12a	7.24ab	7.12ab	3.72a	3.17a	2.26a	29.62b	26.84c
LSD at 0.05	1.14	1.60	1.79	1.00	0.48	0.41	3.78	1.60

Means in each season with the same letter are not significantly different at the 5% level, as determined by Duncan's Multiple Range Test.*CT=Compost tea, **VCT= vermicompost tea, ***SWE= Seaweed extract

As shown in **Table (9),** the spaying of NPK+SWE treatment produced significantly increased the mean of chlorophyll A of Aggizi Shame transplants (6.81 and 9.41 mg/100g) in 2020/2021 and 2021/2022 seasons, respectively, followed SWE alone (1st season) 6.58 mg/100g. On the other hand, CT treatment (1st season) recorded the lowest value (2.49 mg/100g).

Table (9). Effects of foliar spraying with NPK and compost, vermicompost and seaweed extracts on chlorophyll A, B, carotene and carbohydrate of Aggizi Shame olive transplants.

Treatments	Chlorophyll A mg/100g fresh weight		Chlorophyll B mg/100g fresh weight		Carotene mg/100g fresh weight		Carbohydrates mg/100g fresh weight	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	4.91bc	7.10e	1.66c	1.51d	2.25ab	2.48ab	31.57b	26.39cd
NPK	4.59bc	7.81c-e	3.48ab	2.39d	1.54cd	2.39ab	37.12a	31.56a
CT*	2.49d	8.68ab	3.37ab	4.08bc	1.87bc	2.5ab	30.97b	28.19bc
NPK+CT	4.47c	8.48bc	3.69ab	3.86c	1.39cd	2.35bc	35.42a	22.33e
VCT**	4.56bc	7.23de	3.66ab	4.91ab	1.66c	2.30bc	30.32b	25.74d
NPK+VCT	5.67ab	7.97b-d	3.81ab	5.33a	1.63c	2.77ab	31.79b	27.71b-d
SWE***	6.58a	7.15e	3.23b	4.84ab	1.03d	1.87c	36.81a	29.37b
NPK+SWE	6.81a	9.41a	3.96a	5.57a	2.47a	2.89a	37.16a	31.78a
LSD at 0.5	0.15	0.77	0.67	0.88	0.57	0.50	0.27	2.18

Means in each season with the same letter are not significantly different at the 5% level, as determined by Duncan's Multiple Range Test.*CT=Compost tea, **VCT= vermicompost tea, ***SWE= Seaweed extract

Chlorophyll B:

Data illustrated in **(Table 8)** revealed that the combination of NPK with CT or with SWE increased significantly the chlorophyll B in 1st season (8 mg/100g) and 2nd season (3.72 mg/100g), respectively. Conversely, untreated plants exhibited the lowest concentration of chlorophyll B in both seasons for Coratina transplants. (Table 9) shows the significant differences in chlorophyll B ($p < 0.05$) of Aggizi Shame transplants. NPK+SWE treatment gave the maximum content of chlorophyll B (3.96 and 5.57 mg/100g) in both seasons, followed by NPK+VCT (5.33 mg/100g) in second season. Untreated plants (control) treatment had the smallest effect on chlorophyll B (1.66 and 1.51 mg/100g) in both years, respectively.

Carotene:

It is obvious that carotene content **(Table 8)** significantly increased with NPK+SWE treatment (3.17 and 2.26 mg/100g), during 2020/2021 and 2021/2022 growing seasons, consecutively. In contrast, the control treatment recorded the lowest significant values for carotene content in Coratina olive transplants. Statistically significant differences ($p < 0.05$) were found between treatments for carotene content of Aggizi Shame transplants **(Table 9),** where NPK+SWE treatment had the highest values in both seasons (2.47 and 2.89). Compared with other treatments and control treatment in 2020/2021 and 2021/2022. The SWE treatment had the smallest effect on carotene content (1.03 and 1.87 mg/100g) in both years, respectively.

Carbohydrate:

Regarding to the amount of carbohydrate **(Table 8),** foliar spraying application with NPK+CT gave the highest significant values (36.58 and 33.2 mg/100g) in 1st and 2nd seasons, respectively. Followed by treatments compost tea and combination of NPK with VCT (35.82 mg/100g) and (35.13 mg/100g) in 2020/2021 season only. In the contrast, autogenic control record the least values of the carbohydrate content in Coratina olive transplants. All foliar spraying extraction treatments had positive effect on increasing carbohydrate content in both seasons of Aggizi Shame transplants **(Table 9),** The lowest carbohydrate content was observed in the control treatment. In contrast, plants treated with NPK + SWE and NPK alone showed significant increases in carbohydrate content, with values of 37.16 mg/100g and 31.78 mg/100g for NPK + SWE, and 36.58 mg/100g and 33.2 mg/100g for NPK alone, compared to the control in both seasons, respectively.

The addition of vermicompost led to higher carbohydrate and soluble sugar content in plants (Canellas et al., 2015 and Kim et al., 2015). The foliar application of seaweed extract resulted in the highest leaf chlorophyll and carbohydrate content in olive transplants. These findings align with Ibrahim (2013) and Al-Hadethi (2019), suggesting that the increase may be due to micronutrients enhancing the nutritional status of the trees and improving nutrient uptake. NPK foliar spraying had an important function in enzymatic systems and chlorophyll formation and consequently increased photosynthesis which finally increased the yield of olive tree (Kailis and Harris, 2007).

Results indicated that Manzanillo leaves had the highest chlorophyll A and B content but the lowest carotenoids. In contrast, the Koroneiki cultivar had the highest total carbohydrate content and C/N ratio (Othman, 2010).

The application of macro and micronutrients through biofertilizers, like vermicompost, can boost chlorophyll formation, photosynthetic activity, nitrogen metabolism, and auxin levels. These findings are consistent with Musa et al. (2018) and Al-Dulaimy et al. (2016), who found that seaweed extract application at 4 ml/L generally, increased chlorophyll content in olive plants.

Fig. 5. The differences between treatments of Coratina cultivar at 2021/2022 season.

Fig. 6. The differences between treatments of Aggizi Shame cultivar at 2021/2022 season.

CONCLUSION

In conclusion, spraying minerals and organic fertilizers improved olive transplant vegetative parameters, leaf mineral content, photosynthesis pigments, and carbohydrate levels under the study conditions. The best results were achieved with vermicompost tea or seaweed extract combined with NPK. This method enhanced plant structure at planting, leading to better development of both aerial parts and root systems. It also improved rooting in the challenging conditions of Egyptian olive cultivation. Vermicompost tea and seaweed extract with NPK reduced nursery time and facilitated the transfer of plants to permanent fields. Further research is needed to explore the interactions between mineral elements and organic compounds from foliar applications. Nonetheless, the low amounts of inorganic minerals used make this technique highly sustainable.

REFERENCES

Abd-Alhamid, N., Hassan, H.S.A., Laila, F., Haggag and Hassan, A.M. (2015). Effect of Mineral and Bio-fertilization on Vegetative Growth, Leaf Mineral Contents and Flowering of Manzanillo Olive trees.- Int. J. Chem. Tech. Research, 8 (11): 51-61.

Adnan, M. and Anjum, M.Z. (2021). Back to past; organic agriculture. Acta Scientific Agriculture, 5 (2): 01-02.

Adnan, M., Asif, M., Bilal, H.M., Rehman, B., Adnan, M., Ahmad, T., Rehman, H.A., Anjum, M.Z. (2020). Organic and inorganic fertilizer; integral part for crop production. EC Agriculture, 6 (3): 01-07.

Al-Dulaimy, F.Z.A., Mahmood, F.L.A., Al-Hamdani, Kh.A.S., Abd-Al-Rahman, M.A., (2016). Response of Olive seedlings cv. Ashrasi to soil application with Bat (Feces) guano and Seaweed extract (Kelpak). J. Kirkuk Univ. for Agri. Sci., 7(2): 17-31.

Al-Hadethi, E.A.M. (2019). Role of potassium and seaweed extracts on growth and leaf mineral content of “Ashrasi” olive transplants. Plant Archives, 19(2): 144-146.

Amiri, H., Ismaili, A. and Hosseinzadeh, S.R., (2017). Influence of verrnicompost fertilizer and water deficit stress on morpho physiological features of chickpea (*Cicer arietinum* L. cv. Karaj). Compost Science & Utilization, 25 (3):152 65.

Arenas-Castro, S., Gonçalves, J.F., Moreno, M. and Villar, R. (2020). Projected climate changes are expected to decrease the suitability and production of olive varieties in southern Spain. Sci. Total Environ., 709:136161.

Bremner, J.M. and Mulvaney, C.S. (1982). Total nitrogen In: Page, A. L., R.H. Miller and D. R. Keeney (Eds.). Methods of Soil Analysis. Part 2. Amer. Soc. Agron. Madison, W. I.USA. pp. 595-624.

Canellas, L.P., Olivares, F.L., Aguiar, N.O., Jones, D.L., Nebbioso, A., Mazzei, P. and Piccolo, A. (2015). Humic and fulvic acids as biostimulants in horticulture. Scientia Horticulturae, 196:15 -27.

Carranca, C., Brunetto, G. and Tagliavini, M. (2018) Nitrogen Nutrition of Fruit Trees to Reconcile Productivity and Environmental Concerns. Plants (Basel), 7(1): 4.

Duncan, D.B. (1955). Multiple range and multiple F tests. Biomet li, 1-42.

Evenhuis, B. and De Waard P.W., 1980 - Principles and practices in plant analysis. FAO. Soil Bull., 39(1): 152-162.

FAOSTAT (2020). Statistics of the food and agriculture organization of the United Nations.http://www.fao.org/faostat/en/#home.

Fudzagbo, T. and Abdulraheem, M.I. (2020). Earthworms strongly modify microbial biomass and activity triggering enzymatic activities during vermicomposting independently of the application rates of pig slurry. Science of the Total Environment, 385:252-261.

Gul, S. and Safdar, M. (2009). Proximate Composition and Mineral Analysis of Cinnamon. Paki. J. Nut., 8(9): 1456-1460.

Hagagg, L.F., Abd El-Migeed, M.M.M., Shahin, M.F.M., Hassan, H.S.A. and Soad, E. (2012). Effect of Mineral and Organic Fertilization Rates on Vegetative Growth and N, P, K Leaf Content of Olive Seedlings cv. Koroneiki. Australian Journal of Basic and Applied Sciences, 6(7): 570-576.

Haggag, L.F., Merwad, M.A., Fawzi, M.I.F., Shahin, M.F.M. and Genaidy E.A.E. (2014). Impact of Inorganic and Bio-Fertilizers on Growth of “Manzanillo” Olive Seedlings under Greenhouse Condition. Middle East Journal of Agriculture Research, 3(3): 638-644.

Hassan, M.M. (2017). Effect of spraying green plant fertilizer and nourishing solution Grow more on growth of olive seedlings *Olea europaea* L. Anbar Journal of Agricultural Sciences, 2017:51 (Conference Issue).

Hatice, S.T., Korkmaz, B., Selcuk, G., Ozlem, U., Yusef S. and Aydin, A. (2020) The

Effect of Organic Fertilization on Olive Sapling Cultivation: Vermicompost as an Example. Fresenius Environmental Bulletin, 29(07A): 5735-5738.

Hosseinzadeh, S.R., Arniri, H. and Ismaili, A. (2016) Effect of verrnicompost fertilizer on photosynthetic characteris tics of chickpea (*Cicer arietinum* L.) under drought stress. Photosynthetica, 54 (1):87 92.

Hussein, M.A. and Emadeldin H. (2018). Effect of macro nutrients and nano-boron foliar application on vegetative growth, yield and fruit quality of Manzanillo olive. Alex. Sci. Exch. J., 39(3): 394-400.

Ibrahim, R.Z.. (2013). Effect of foliar spray of ascorbic acid, zn, seaweed extracts (sea) force and biofertilizers (em-1) on vegetative growth and root growth of olive (*Olea europaea* L.) transplants cv. Hojblanca. Int. J. Pure Appl. Sci. Technol., 17(2): 79-89.

Ismael, A.A. and Gray, A.K. (2012). Response of Olive transplants to seaweed extract as soil application and foliar application of magnesium. Iraqi J. Agri. Sci.,43 (2): 119-131.

Jackson, M.L. (1973). Soil Chemical Analysis", Constable Co., Itd., London, pp: 23-29.

Kailis, S.G. and Harris, D. (2007). Producing table olives. National Library of Australia Cataloguing in Publication Entry, pp: 345.

Kim, M.J., Shim, C.K., Kim, Y.K., Hong, S.J., Park, J.H., Han, E.J., Kim, J.H. and Kim, S.C. (2015). Effect of aerated compost tea on the growth promotion of lettuce, soybean, and sweet corn in organic cultivation. Plant Pathology Journal, 31 (3):259 68.

Langgut, D., Cheddadi, R., Carrión, J.S., Cavanagh, M., Colombaroli, D., Eastwood, W.J., Greenberg, R., Litt, T., Mercuri, A.M., Miebach, A., and et al. (2019). The origin and spread of olive cultivation in the Mediterranean Basin: The fossil pollen evidence. Holocene, 29: 902–922.

Mahmoud, T.S.M., Mohamed, E.S.A. and El-Sharony, T.F. (2017). Influence of foliar application with potassium and magnesium on growth, yield and oil quality of "Koroneiki" olive trees. American Journal of Food Technology. 12: 209-220.

Musa, S.I., Njoku, L.K. and Ndiribe, C.C. (2018). The Effect of Vermi Tea on the Growth Parameters of *Spinacia oleracea* L. (Spinach). Journal of Environmental Science and Pollution Research, 3(4): 236–238

Olsen, S.R. and Sommers, L.E. (1982). Phosphorus. In. Page A.L.R. H. Miller, and D.R. Keeney (Eds.). Methods of Soil Analysis, part2, Amer. Soc. Agron. Madison, W.I. USA. pp. 403 – 430.

Osman, S.M., Khamis, M.A. and Thorya, A.M. (2010). Effect of Mineral and Bio-NPK Soil application on Vegetative Growth, Flowering, Fruiting and Leaf Chemical Composition of Young Olive Trees. Res. J. Agri. Biol. Sci., 6(1): 54-63.

Othman S.M. (2010). Effect of mineral, Bio-NPK soil application of young olive trees and foliar fertilization on leaf and shoot chemical composition. Res. J. Agric. and bio. Sci., 6(3): 311-318.

Palm, C.A., Gachengo, C.N., Delve, R.J., Cadisch, G. and Giller, K.E. (2001). Organic inputs for soil fertility management in tropical agro ecosystems: application of an organic resource database. Agric. Ecosystem Environ., 83: 27-42.

Rediam (2020) Red de Informacion Ambiental de Andalucía. Available at: http://www.juntadeandalucia.es/medioambiente/site/rediam/menuitem.

Saad, M., Qureshi, K.M., Shah, F.H., Hafiz, S.M., Talha, M. and Tabassum M.I. (2021). Impact of organic media and NPK amendments on growth of olive seedlings. J Agric. Res., 59 (1):43-50

Sangha, J., Kandasamy, S., Khan, W., Bahia, N., Singh, R., Critchley, A. and Prithiviraj, B. (2015). A-Carrageenan Suppresses Tomato Chlorotic Dwarf Viroid (TCDVd) Replication and Symptom Expression in Tomatoes. Mar. Drugs, 13: 2875–2889.

Saric, M., Kastroi, R., Curic, R., Cupina, T. and Geric, I. (1967). Chlorophyll determination. Univ. Unoven Sadu

Parktikum is Fiziologize Biljaka, Beagard, Hauncna, Anjiga.

Sendecor, G.W. and Cochran, G.W. (1990). Statistical methods.7th Ed., Iowa State Univ. USA. P.593.

Shaban, H. and Nasab, B. (2015). An Overview of the Benefits of Compost tea on Plant and Soil Structure. February 2015Advances in Bioresearch, 6(61):154-158.

Shukla, P.S., Borza, T., Critchley, A.T., Hiltz, D., Norrie, J. and Prithiviraj, B. (2018). Ascophyllum nodosum extract mitigates salinity stress in Arabidopsis thaliana by modulating the expression of miRNA involved in stress tolerance and nutrient acquisition. PLoS ONE 13, e0206221.

Siddiqui, Y., Meon, S., Ismail, R., Rahmani, M. and Ali A. (2008). Bio-efficiency of compost extracts on the wet rot incidence, morphological and hysiological growth of okra *Abelmoschus esculentus* [(L.) Moench]). Sci Hortic., 117(1):9–14.

Toor, M.D., Adnan, M., Javed, M.S., Habibah, U., Arshad, A., Din, M.M. and Ahmad, R. (2020). Foliar application of Zn: Best way to mitigate drought stress in plants; A review. International Journal of Applied Research, 6(8): 16-20.

Zaccardelli, M., Pane, C., Villecco, D., Maria, Palese, A. and Celano, G. (2018). Compost tea spraying increases yield performance of pepper (*Capsicum annuum* L.) grown in greenhouse under organic farming system. Italian Journal of Agronomy, 13(3):229-234

Zipori, I., Erel, R., Yermiyahu, U., Ben-Gal, A. and Dag A. (2020). Sustainable management of olive orchard nutrition: A review. Agriculture, 10(1): 1-22.

Zouari, I., Beligh, M., Meriem, T., Olfa, D., Imed, C., Amel, M., Khouloud, A., Foued, L., Faouzi, A., Mohamed, H. and Mezghani, M.A. (2020). Olive oil quality influenced by biostimulant foliar fertilizers. Brazilian Journal of Biological Sciences, 7(15): 3-18.

الملخص العربي

تحسين النمو الخضري لشتلات صنفين من الزيتون عن طريق الرش الورقي لبعض المستخلصات العضوية والاسمدة الكيميائية

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تم تصميم الدراسة الحالية لمعرفة تأثير NPK، الاسمدة العضوية ومستخلص الأعشاب البحرية على شتلات عمر شهرين لأصناف الزيتون (كوراتينا وعجيزي شامي)، لتحسين النمو الخضري وتقليل فترة بقاء الشتلات في المشتل للوصول للحجم المناسب للبيع. تمت دراسة العديد من عوامل النمو المختلفة، بالاضافة الي المحتوى المعدني من العناصر في الورقة، ومحتوى صبغات البناء الضوئي في الأوراق. أجريت التجارب في صوبة معهد بحوث البساتين خلال موسمي 2021/2020 و2022/2021 المتتاليين. تم استخدام تصميم القطاعات العشوائية الكاملة.

أظهرت النتائج استجابة لشتلات الزيتون صنف. "كوراتينا" للرش الورقي بـ NPK أدى إلى زيادة معنوية في طول النبات وطول الجذر. ومع ذلك، فإن الاستخدام الورقي مع مستخلص الكمبوست + NPK يزيد من الكلوروفيل A والكربوهيدرات، وأدي استخدام الأعشاب البحرية بالاضافة الي NPK زيادة في طول الجذر، وعدد الأفرع الجانبية، وقطر الساق، وزيادة نسبة النيتروجين، والفوسفور، والكالسيوم، والمغنيسيوم، والكلوروفيل ب والكاروتين.

علاوة على ذلك، أوضحت النتائج أن استخدام الرش الورقي ب مستخلص الفيرميكمبوست + NPK علي شتلات الزيتون صنف العجيزي أدي الي الحصول علي أفضل طول للجذر وطول للنبات. بينما كان استخدام الأعشاب البحرية + NPK الأكثر مثالية للرش الورقي لمعظم الصفات مثل عدد الأفرع الجانبية، عدد الأوراق/النبات، قطر الساق، البوتاسيوم، الكالسيوم، المغنيسيوم، الكلوروفيل (أ و ب) ومحتوى الكربوهيدرات في كلا صنفي شتلات الزيتون.

ومن ثم، يوصى باستخدام الرش الورقي بمستخلص الفيرميكمبوست (VCT) أو الأعشاب البحرية NPK + (SWE) والتي يمكن أن تحسن نمو شتلات الزيتون بنجاح.