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Effect of Mineral and Organic Fertilization Rates on Vegetative Growth and N, P, K Leaf Content of Olive Seedlings cv. Koroneiki

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Abstract: This study was carried out on cultivated Koroneiki olive transplants grown at the greenhouse of National Research Center, Dokki, Giza governorate. The investigation aimed to study the effect of applying NPK, supermax on vegetative growth of Koroneiki olive seedlings planted in plastic bags at nursery stage. After planting Koroneiki olive seedlings, the following treatments were applied: T1: NPK (20% N: 20% P: 20% K) at four rates (0, 120, 180 and 240 g\plant\year), T2: green power with four rates of applications (0, 16, 32 and 48 cm \plant\year), also the interaction between NPK, green power treatments were studied. At the end of the season, percentage of plant height increment, leaf number per plant, shoot number per plant, stem diameter, leaves dry weight %, root number, root length and N,P,K leaf content were determined and recorded. The obtained results revealed that fertilization olive seedlings cv. Koroneiki with high rate of green power (organic fertilization) at 6 cm\ plant every 30 days and using NPK (mineral fertilization) at 180 gm/ plant/ year increased significantly Percentage of plant height increment, Leaf and Shoots number per plant, Leaf dry weight percentage, Phosphor and Potassium leaf content. However, root number and length were improved by high rate of green power treatment (6cm\ plant) + low rate of NPK (120 gm / plant/ year). With respect to nitrogen leaf content, the highest value obtained from seeding fertilized with NPK at the high rate (240 gm / plant/ year) + medium rate of green power treatment (6cm\ plant). Whereas, stem diameter of Koroneiki olive seedlings increased significantly by fertilizing with green power at medium or high rates individually.

Keywords: Koroneiki Olive seedling; NPK; vinasse; amino acids; organic fertilization; green power; mineral fertilization; vegetative growth; leaf mineral content.

INTRODUCTION

Olive (*Olea europaea* L.) is an important perennial crop in many agricultural regions of the Mediterranean countries, as it is the most important olive growing region. Generally, geomorphic processes associated with erosion sedimentation have caused substantial changes in soil properties along the slopes of these areas [Burke, T.H., 1984].

Mineral nutrients are inorganic elements that have essential and specific functions in plant metabolism which results in normal plant growth and crop production (Mengel and Kirkby, 1987). Nitrogen is of vital importance for plant growth due to being a part of amino acid, protein, enzymes and chlorophyll molecule (Devlin and Witham, 1986). Potassium is necessary for basic physiological functions such as formation of sugars and starch, synthesis of proteins and cell division and growth [Obreza, T.A., 2003 & Abbas, F. and A. Fares, 2008]. Phosphorus is necessary for many life processes such as photosynthesis, synthesis and breakdown of carbohydrates and the transfer of energy within the plant [Obreza, T.A., 2001].

One of the main factors affecting plant growth in sandy soils is the types and amounts of fertilizers. However, the cost of mineral fertilizers has been significantly going up and up. As a result, it has become necessary to seek alternatives that would supply the poor soil with more economic sources of fertilizers (Rodriguez, 2000).

Organic materials have the benefit or disadvantage of being slow release and are less likely to leach into ground or surface waters. Conventional fertilization has traditionally been used because they are cheap, less bulky and easy to apply. The line between is becoming blurred with slow release conventional fertilizers and high analysis organic fertilizers that are easily applied and less bulky.

Vinasse improves almost factors involved in soil fertility, provides favoring conditions for nitrogen assimilation into the soil, protects nutrients against washing out in winter and maintains them as reserve nutrients as a slow release during the vegetative period. These are the most important affect, leading to increase yield and quality of crops.

Vinasse is a byproduct of distilleries during alcohol production. In terms of volume, approximately 13 L of vinasse are produced by each L of alcohol obtained from cane must (Copersucar. 1986). Vinasse has high levels of potassium, calcium and organic matter in its chemical composition as well as moderate amounts of nitrogen

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and phosphorus (Gloria, N. 1985) and could represent an alternative to supply such nutrients in crop production (García, A. 1994, Gloria, N. 1985). Various research works carried out in other countries, particularly in Brazil, report that vinasse increases sugarcane productivity (Copersucar. 1980, Copersucar. 1986, Gloria, N. 1985) as well as they have demostrated that under controlled conditions, it can partially or completely replace mineral fertilization.

On the other hand, Bioregulator substances were shown to enhance the biosynthesis of certain chemical constituents in plants. In this respect the amino acids which have a high integrity with different metabolic pools in plants were used to promote plant growth (Coruzzi and Last, 2000). Maxwell and Kieber (2004) indicated the link of methionine to the biosynthesis of growth regulating substances, e.g. cytokinins, auxins and brassinosteroids in plants. Whereas the link of tryptophan to the biosynthesis of auxins, the phytoalexin camalexin, phenyl propanoids and other related natural products in plants was recently reported (Tao *et al*. 2008). Studies have proved that amino acids can directly or indirectly influences the physiological activities of plant growth and development.

Amino acids as organic nitrogenous compounds are the building blocks in the synthesis of proteins (Davies, 1982). Amino acids are particularly important for stimulation cell growth, they act as buffers which help to maintain favorable PH value within the plant cell, since they contain both acid and basic groups; they remove the ammonia from the cell.

This function is associated with amid formation, so they protect the plants from ammonia toxicity. They can serve as a source of carbon and energy, as well as protect the plants against pathogens. Tyrosine is hydroxy phenyl amino acid that is used to build neurotransmitters and hormones. Hass (1973) stated that the biosyntheses of cinamic acids (which are the starting materials for the synthesis of phenols) are derived from phenylalanine and tyrosine.

The role of Tryptophan is well known: it has an indirect role on the growth via its Influence on auxin synthesis. Phillips (1971) reported that alter native routes of IAA synthesis exist in plants, all starting from Tryptophan. Thus, when Tryptophan was supplied to some plant tissues IAA was formed. Thiamine (vitamin B1) could serve as coenzyme in decaboxylation of a-keto acids, such as Pyruvic acid and keto-glutamic acid which has its importance in the metabolism of carbohydrates and fats (Bidwell, 1974). Thiamine is an important cofactor for the transketolation reactions of the pentose phosphate cycle, which provides pentose phosphate for nucleotide synthesis and for the reduced NADP required or various synthetic pathways (Kawasaki, 1992).

The objectives of the present study, are based on the possible use of green power (organic nutrient) to replace the fertilization of potassium and partially replace fertilization with Nitrogen and phosphorus due to its content of vinasse which contain high levels of the organic matter, potassium, calcium and moderate amount of N and P. Also, the use of green power as a fertilizer source applied at different doses combined with different rates of mineral fertilizers (NPK) on plant growth and leaf mineral content of Koroneiki olive seedlings grown on sandy soil mixed cattle manure.

MATERIAL AND METHODS

This study was carried out on healthy olive seedling cv. Koroneiki and almost uniform seedlings cultivated in black polyethylene bags with 30 cm diameter fooled with 10 kg washed sand mixed very good with 2.5 kg cattle manure in the experimental research green house of National Research Center at dokki, Giza governorate Egypt. The investigation aimed to study the effect of applying mineral fertilization represented by NPK Crystalon (20% N: 20% P: 20% K) and and organic fertilization represented by green power source (20% soybean amino acids extract and 80% vinasse). The NPK and green power used in this study as a direct soil application on Koroneiki transplants at the nursery.

The following treatments were investigated:

NPK Crystalon (20% N: 20% P: 20% K) applied as soil application at four rates 0, 120, 180 and 240 g\plant\year divided into 16 doses from March to October about one dose every 15 day at four rates 0, 7.5 (low rate), 11.25 (medium rate) and 15 (high rate) g NPK \ plant\15 day.

Green power applied applied as soil application at four rates 0, 16, 32 and 48 cm \plant\year divided into 8 doses from March to October about one dose every 30 day at four rates 0, 2, 4, 6 cm\ plant \30 day. Thus, the experiment was conducted as follows:

1- Control.
2- 2 cm green power \ plant \30 day.
3- 4 cm green power \ plant \30 day.
4- 6 cm green power \ plant \30 day.
5- 120g NPK \ plant\15 day.
6- 120 g NPK \ plant\15 day + 2 cm green power \ plant \30 day.
7- 120 g NPK \ plant\15 day + 4 cm green power \ plant \30 day.
8- 120 g NPK \ plant\15 day + 6 cm green power \ plant \30 day.

9- 180 g NPK \ plant\15 day
10- 180 g NPK \plant\15 day + 2 cm green power\plant\30 day.
11- 180 g NPK \plant\15 day + 4 cm green power\plant\30 day.
12- 180 g NPK \plant\15 day + 6 cm green power\plant\30 day.
13- 240 g NPK \ plant\15 day.
14- 240 g NPK \ plant\15 day + 2 cm green power \ plant \30 day.
15- 240 g NPK \ plant\15 day + 4 cm green power \ plant \30 day.
16- 240 g NPK \ plant\15 day + 6 cm green power \ plant \30 day.

The treatments were arranged in randomized complete block design with six replicates for each treatment and each replicate was represented by three plants. At the end of October plants of each treatment were removed genteelly with their root system to estimate and record the following data:

- Vegetative grow parameter:

1- Percentage of plant height increment.
2- Shoot number per plant.
3- Stem diameter (mm).
4- Leaf number per plant.
5- Leaf dry weight %.
6- Root number.
7- Root length (cm).

- leaf mineral content

1. Nitrogen
2. phosphor
3. Potassium

Chemical analysis was determined according to the methods described by Cottenie *et al*., (1982).

Statistical Analysis:

The data were subjected to analysis of variance and the method of Duncan's was used to differentiate means, Duncan (1955).

3. Results:

Percentage of Plant Height Increment:

Table (1) results showed that Percentage of plant height increment responded significantly to the low (140 g \ plant\year) and medium rate (180 g \ plant\year) of mineral fertilization. However, increasing NPK rate up to 50 g actual NPK \ plant decreased the increment 0f plant high% significantly. Generally, olive seedling plant high% increased significantly with increasing green power rates up to 4 cm \ plant. Studying the impact of interventional for mineral and organic fertilization, the highest Percentage of plant height increment was recorded from using 180 g + 4 cm green power \ plant\year.

Leaf Number Per Plant:

Data in table (2) showed that, leaf number values were decreased significantly with increasing NPK rates. On contrary, application of green power at low (2cm\ plant) and medium rate (4cm\ plant) increase Leaf number per plant significantly. whereas, increasing NPK to the maximum rate (240 g\ plant\year) with green power at the medium rate (4cm\ plant) significantly reduced the increment in the leaf number per plant obtained from fertilizing of mineral and organic fertilizer at the medium rate. Similarly, increasing green power to the maximum rate with NPK at medium rate followed the same obtained trained.

Shoots Number Per Plant:

As shown in table Table. (3), shoots number per plant was affected by different rates of NPK alone. Whereas, highest shoots number per plant was recorded from seedlings recived NPK with green power at the medium rate, it is interested to notice that increasing green power rate from the medium to the high rate with NPK at medium rate showed similar effect on shoots number per plant. On contrary, the precence of NPK at the high rate with green power at medium rate reduced the increament obtained from medium NPK and green power rate .

Stem Diameter:

It is obvious from data in Table (4) that stem diameter values slightly decreased with NPK fertilization without using green power. On the other hand noticeable gradually increase in stem diameter with increasing green power fertilization rate. Whereas, the presence of mineral fertilization at any rate with green power at the medium or high rate decreased significantly stem diameter comparing with using green power alone, in other words no positive effect on stem diameter was detected due to NPK fertilization.

Table 1: Percentage of plant height increment as affected by rats of NPK and green power fertilization on Koroneiki Olive seedlings.

Treatment	without Green power	Green power 2cm \ plant	Green power 4cm \ plant	Green power 6cm \ plant	Mean
0 NPK	106.7 n	156.7 j	200 e	186.7 g	162.5 C
120 g NPK	140 m	196.7 f	236.7 b	203.3 d	194.2 A
180 g NPK	163.3 i	216.7 c	256.7 a	143.3 l	195 A
240 g NPK	150 k	186.7 g	163.3 i	173.3 h	168.3 B
Mean	140 D	189.2 B	214.2 A	176.7 C	

Table 2: Leaf number per plant as affected by rats of NPK and green power fertilization on Koroneiki Olive seedlings.

Treatment	without Green power	Green power 2cm \ plant	Green power 4cm \ plant	Green power 6cm \ plant	Mean
0 NPK	48 m	107 c	105 d	92 f	88 A
120 g NPK	63 l	78 h	109 b	88 g	85 B
180 g NPK	69k	72 j	112 a	74 i	82C
240 g NPK	70 k	88 g	98 e	62 l	80 D
Mean	63 D	86 B	106 A	79 C	

Table 3: Lateral shoot number per plant as affected by rats of NPK and green power fertilization on Koroneiki Olive seedlings.

Treatment	without Green power	Green power 2cm \ plant	Green power 4cm \ plant	Green power 6cm \ plant	Mean
0 NPK	3 c	3 c	4 b	4 b	4 A
120 g NPK	3 c	3 c	3 c	3 c	3 B
180 g NPK	3 c	4 b	5 a	5 a	4 A
240 g NPK	3 c	3 c	4 b	3 c	3 B
Mean	3 B	3 B	4 A	4 A	

Table 4: Stem diameter as affected by rats of NPK and green power fertilization on Koroneiki Olive seedlings.

Treatment	without Green power	Green power 2cm \ plant	Green power 4cm \ plant	Green power 6cm \ plant	Mean
0 NPK	2.3 f	2.2 g	3.3 a	3.3 a	2.8 A
120 g NPK	2.3 f	2.4 e	2.5 d	2.5 d	2.4 D
180 g NPK	2.4 e	2.5 d	2.7 c	2.7 c	2.6 B
240 g NPK	2.2 g	2.9 b	2.5 d	2.4 e	2.5 C
Mean	2.3 C	2.5 B	2.7 A	2.7 A	

Leaf Dry Weight %:

Obviously Table (5) cleared that, leaf dry weight percentage was generally responded significantly to NPK fertilization and\or green power. Whereas, highest leaf dry weight percentage was obtained when using green power at the high rate.

Root Number:

Results in Table (6) cleared that, root number was not affected significantly by different rates of NPK fertilization, but green power at high rate (6cm\ plant) when combined with NPK at low or medium rate (120 or 240 g\ plant\year) increased root number per plant . On other words, root number responded positively to increasing green power application rates, while this trained was not noticed in concerns of NPK application rate.

Root Length:

It is obvious from data in Table (7) that root length in Koroneiki olive seedlings responded insignificantly to different rates of NPK fertilization. Whereas, using green power at high rate (6cm\ plant) combined with NPK at low or medium rate (120 or 240 g\ plant\year) increased root length per plant. On other words, root length responded positively to increasing green power (organic fertilization) application rates, while this trained was not noticed in concerns of NPK (mineral fertilization) application rate.

Nitrogen Leaf Content:

As shown in Table. (8), Nitrogen leaf content was increased significantly by increasing NPK fertilization rates. Whereas, highest Nitrogen leaf content was obtained from Koroneiki olive seedlings fertilized with NPK at the highest rate (240 g\ plant\year) combined with green power at medium rate (4cm\ plant).

Phosphor Leaf Content:

Data in table (9) showed that, phosphor leaf content values responded positively to increasing NPK fertilization rates. Similarly, increasing green power application rates increased phosphor leaf content of Koroneiki olive seedlings. Whereas, combination of NPK and green power at medium or high rates recorded the highest phosphor leaf content.

Table 5: Leaves dry weight %. as affected by rats of NPK and green power fertilization on Koroneiki Olive seedlings.

Treatment	without Green power	Green power 2cm \ plant	Green power 4cm \ plant	Green power 6cm \ plant	Mean
0 NPK	43.9 p	49.4 o	54.5 m	55.7 k	50.9 D
120 g NPK	53 n	55.1 l	59.3 h	60.7 g	57 C
180 g NPK	57 j	61.1 f	63.4 c	65.1 a	61.6 B
240 g NPK	58.3 i	61.8 e	63.2 d	64.8 b	62 A
Mean	38.5 D	41.4 C	44.3 B	45.4 A	

Table 6: Root number as as affected by rats of NPK and green power fertilization on Koroneiki Olive seedlings.

Treatment	without Green power	Green power 2cm \ plant	Green power 4cm \ plant	Green power 6cm \ plant	Mean
0 NPK	3cd	6 b	4 c	4 c	4 A
120 g NPK	4 c	4 c	6 b	8 a	5 A
180 g NPK	3 cd	4c	6 b	7 ab	5 A
240 g NPK	2 d	3 cd	4 c	6 b	4 A
Mean	3C	4BC	5 AB	6 A	

Table 7: Root length as affected by rats of NPK and green power fertilization on Koroneiki Olive seedlings.

Treatment	without Green power	Green power 2cm \ plant	Green power 4cm \ plant	Green power 6cm \ plant	Mean
0 NPK	10 h	15 d	14 e	13 f	13 B
120 g NPK	8 i	8 i	21 b	22 a	14.7 A
180 g NPK	5 k	13 f	14e	18 c	12.5 C
240 g NPK	3 l	7 j	8 i	12 g	7.5 D
Mean	6.5 D	10.7 C	14.2 B	16.2 A	

Table 8: Nitrogen leaf content as affected by rats of NPK and green power fertilization on Koroneiki Olive seedlings.

Treatment	without Green power	Green power 2cm \ plant	Green power 4cm \ plant	Green power 6cm \ plant	Mean
0 NPK	1.3 h	1.7 g	2.3 c	2 f	1.82 D
120 g NPK	2.1 e	2.2 d	2.3 c	2 f	2.15 C
180 g NPK	2.3 c	2.2 d	2.3 c	2.1 e	2.22 B
240 g NPK	2.4 b	2.3 c	2.5 a	2.1 e	2.32 A
Mean	2.02 C	2.1 B	2.35 A	2.05 C	

Potassium Leaf Content:

Data in table (10) indicated that, green power (organic fertilization) applications improved potassium leaf content which reached the optimum level in leaves by using the high rate of green power (6cm\ plant). However, addition NPK (mineral fertilization) at any rate had no significant effect on phosphor leaf content of Koroneiki olive seedlings.

Table 9: Potassium leaf content as affected by rats of NPK and green power fertilization on Koroneiki Olive seedlings.

Treatment	without Green power	Green power 2cm \ plant	Green power 4cm \ plant	Green power 6cm \ plant	Mean
0 NPK	0.53 e	0.86 d	0.98 c	1.12 ab	0.87 B
120 g NPK	1.13 ab	1.14 a	1.12 ab	1.15 a	1.14 A
180 g NPK	1.12 ab	1.14 a	1.13 ab	1.15 a	1.13 A
240 g NPK	1.1 bc	1.13 ab	1.1 bc	1.16 a	1.12 A
Mean	0.97 C	1.07 B	1.08 B	1.15 A	

Table 10: Phosphor leaf content as affected by rats of NPK and green power fertilization on Koroneiki Olive seedlings.

Treatment	without Green power	Green power 2cm \ plant	Green power 4cm \ plant	Green power 6cm \ plant	Mean
0 NPK	0.04 k	0.05 j	0.06 i	0.08 h	0.06 D
120 g NPK	0.09 g	0.11 e	0.12 d	0.13 c	0.11 C
180 g NPK	0.1 f	0.11 e	0.16 a	0.16 a	0.13 B
240 g NPK	0.13 c	0.15 b	0.16 a	0.16 a	0.15 A
Mean	0.09 C	0.11 B	0.13 A	0.13 A	

Discussion:

From the abovementioned results, it could concluded that fertilization olive seedlings cv. Koroneiki with high rate of green power (organic fertilization) at 6 cm\ plant every 30 days and using NPK (mineral fertilization) at 180 g\ plant\year increased significantly Percentage of plant height increment, Leaf and Shoots number per plant, Leaf dry weight percentage, Phosphor and Potassium leaf content. However, root number and length were improved by high rate of green power treatment (6cm\ plant) + low rate of NPK (120 gm / plant/ year. With respect to nitrogen leaf content, the highest value obtained from seeding fertilized with NPK at the high rate (240 g\ plant\year) + medium rate of green power treatment (6cm\ plant). Whereas, stem diameter of

Koroneiki olive seedlings increased significantly by fertilizing with green power at medium or high rates individually.

The obtained results are in harmony with those obtained by Mustafa *et al*. (2011) , Laila F. Hagag *et al*. (2011), Hassan *et al*. (2010) , Osman *et al*. (2010) and Nawaf and Yara (2006) Who indicated that NPK are considering being essential element for plant growth and development and applying crystalon (20:20:20 NPK) as soil application was the most effective on growth performance. With respect to the influence of green power (20% soybean amino acids extract and 80% vinasse), several authors indicated the primitive effect of amino acids on plants growth including, Aml *et al*. (2011) on olive seedlings. On the other side, the effect of amino acids may be explained due to Coruzzi and Last (2000) who stated that, amino acids which have a high integrity with different metabolic pools in plants were used to promote plant growth. Maxwell and Kieber (2004) indicated the link of methionine to the biosynthesis of growth regulating substances, e.g. cytokinins, auxins and brassinosteroids in plants. Whereas the link of tryptophan to the biosynthesis of auxins, the phytoalexin camalexin, phenyl propanoids and other related natural products in plants was recently reported. Waller and Nowaki (1978) who suggested the regulatory effects of certain amino acids like phenylalanine and ornithine, on plant development is through their influence on gibberellins. In this respect, Hashimoto and Yamada (1994) reported that several alternative routes of IAA synthesis in plants starting from amino acids.

Also, the work proved the beneficial effects of vinasse recycling as a substitute for chemical fertilizers. Mona (2010) working on the possible use of diluted vinasse as a partial replacement with mineral fertilizer sources for wheat production and improving nutritional status in sandy soil. Indicated that, enriched vinasse with macronutrients led to significantly increase the available N, P and K nutrients in the soil. Moreover, application of mineral fertilizers at 50 and 75 % from the recommended dose led to significant increases N, P and K uptake in straw and grains of wheat than vinasse without mineral fertilizers treatments. Also Gemtos *et al*. (1999) reported that, addition of vinasse wastes caused a significant decrease in soil pH and significant increases in soil available P, total N, and total organic compound. Also recoded an increase in N, K leaf content was caused by vinasse application.

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