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ChemTech

International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN: 0974-4290
Vol.8, No.10 pp 27-32, 2015

Effect of olive cultivar on growth parameters, mineral constituents and cation – exchange capacity of fiberous roots

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Abstract: This investigation was conducted during 1994 – 1995. The objective of this experiment was to determine the annual pattern of root and shoot growth of young plants (originally propagated by stem cutting) of different olive cultivars, mineral constituents and cation – exchange capacity of fibrous roots. Uniform 5-month- old plants of four cultivars were grown in the nursery of the Faculty of Agriculture, Cairo University at Giza. The cultivars were: Picual, Coratina, Manzanillo and Agezi Shami. Olive plants were planted in above-ground rhiziotrons. Pllastic barrels rhizotrons were 50 cm in diameter and 90 cm in depth were filled with sand and clay (8:1 byvolume). Manzanillo cultivar had the highest fibrous root growth rate (6.12 cm / day), while Agizi Shami cultivar had the lowest growth rate (2.31 cm/day). Picual and Agizi shami cultivars showed 5 growth cycles of fibrous roots. Whereas, coratina cultivar appeared 6 growth cycles, while, Manzaniilo cultivar had 4 growth cycles. Major periods of growth for each type generally occurred during the summer time. Levels of N and P in the leaves were higher than those of shoots and roots for all cultivars. However, root contents of K, Ca, Mg and Na were higher than those of shoot and leaves. There were no significant differences between the cultivars in mineral content. However, cation- exchange capacity (C.E.C.) was different according to cultivar. coratina cultivar had the higher rate of C . E. C, while Picual cultivar had the least, whereas Agizi Shami and Manzanillo cultivars had medium rates.

Key words: Root system, vegetative growth, mineral content, cation – exchange.

Introduction

Olive cultivation is moving from traditional, marginal areas to new areas where modern technologies can be used for mechanical pruning and especially harvesting. This change is occurring both in traditional olive producing countries and in new countries where olive growing is rapidly expanding [1].

Olive is considered one of the important fruit crops in Egypt. The Spanich cv. Manzanillo is the most important commercial variety in the world. Manzanillo is early ripening cultivar, good for table olives and for oil production and a heavy bearer .Under sandy soil conditions, olive plants suffer from the lack of macro and micro nutrients. Growth of the trees is weak and this reflects on reducing tree production [2]. Seasonal growth of roots consists of two separate components: (1) Elongation of existing roots and (2) Initiation of laterals and their subsequent elongation. Therefore, growth periodicity of the total root system is often very different from that of individual roots within it. Basic patterns of the root systems of tree crops vary with species and is greatly influenced by environmental variables, e.g. Soil temperature and soil moisture [3].The greatest root density values were not consistently associated with the most olive cultivars -Difference in tree height and canopy volume between cultivars were not associated with concomitant difference in fibrous root density, or length density in some large trees such as Frantoio, although deep rooted, did not have large root density or length density values, while the small trees of Agizi shamy cultivar had shallow, but dense root systems[4]. Elezaby [5] studied root growth cycles of olive trees and their relation to shoot growth cycles, olive trees showed clear seasonal peaks of root growth. Agizi Shamy and Picual root systems showed one major peak and 1-2 minor peaks of root activity per season.The issue of which organ initiates growth first is unsettled. The growth periods may overlap particularly in flushes which occur after the spring cycle since the growth of one component does not necessarily eliminate simultaneous growth of the other, some roots are probably elongating at any given time. A cyclic growth pattern is not unreasonable since each major organ is basically heterotrophic and competes for the available food supply. The normal distribution of plant assimilates becomes temporarily unbalanced to support the growing and more competitive organ [6].The leaf constituents of mineral elements were influenced by cultivar. Kunwar [7] has compared the mineral content of some olive cultivars, noticed that leaf N content was highest in cultivar Comi Co Bra Atticao (2.48%) and lowest in Leccino (1.63%); P content was highest in Pendolino (0.19%) and lowest in Leccino (0.14%) whereas K content was highest in Moraiolo (1.94%) and lowest in Pendolino (1.46%) and Mg content was highest in Comi Co Bra Atticao (0.73%) and lowest in cannino (0.42%) . Elezaby [4] has compared leaf mineral constituent of Agizi Shamy, Frantoio, Manzanillo and Picual olive cultivars at the age of 3 and 4 years. Trees with highest N content were those of Manzanillo, while Agizi Shamy trees had the lowest N content. Trees of remaining cultivars showed intermediate values. Regarding leaf P content, it is evident that leaves of Picual trees had the lowest P content. Leaves of Manzanillo and Frantoio had the highest K content. There were no statistical differences between the mean Ca, Mg and Mn contents of leaves from the different cultivars.The total cations which can be replaced under a given set of conditions is known as the cation-exchange capacity (C.E.C) of the roots and is expressed as me per 100 g of roots [8].

The objective of this experiment was to determine the annual pattern of root and shoot-growth of young plants (originally propagated by stem cutting) of different olive cultivars, mineral constituents and cation – exchange capacity of fibrous roots.

Materials and Methods

This investigation was conducted during 1994–1995. The objective of this experiment was to determine the annual pattern of root and shoot-growth of young plants (originally propagated by stem cutting) of different olive cultivars, mineral constituents and cation – exchange capacity of fibrous roots.

Uniform 5-month- old plants of four cultivars were grown in the nursery of the Faculty of Agriculture, Cairo University at Giza. The cultivars were: Picual, Coratina, Manzanillo and Agezi Shami. Olive plants were planted in above-ground rhiziotrons. Pllastic barrels rhizotrons were 50 cm in diameter and 90 cm in depth were filled with sand and clay (8:1 by volume). The barrels were cut and fit with transparent glass faces 35cn wide and 45 cm deep from the plant. Each barrel had holes in the bottom to allow the free drainage of water. Carton shields were made to cover the glass faces. The shields were removed only when root growth reading were taken. Each rhizotron was planted with a single, plant that had grown for the previous year in a 2L. pot. Plants were established in the rhizotrons for about two months before measurements of shoot and root growth. Three rhizotrons for each cultivar were used for each of the four cultivars.

Shoot and root growth measurements:

Linear extension of shoots and roots in each rhizotron was measured every 15 days. Randomly chosen shoot at each rhizotrons in the exterior protions of the canopy was monitored. Tagged nodes on each of the monitored shoots were used as a reference points and shoot extension was determined on each sampled date by measuring from the reference nodes to the ends of terminals.

Root growth was recorded by tracing root with an indelible marking pen on clear plastic sheets that were placed over the viewing face.

Growth rate for shoots and roots of a given plant was computed with the following formula:

Mean linear growth for shoots (mm/day) = $\frac{\text{total growth}}{no.days}$

Where total growth = the total growth of all measured shoots or roots in mm since the last measurement and no. days = the number of days since the last measurements were taken. Air temperatures were recorded. Standerd horticultural management (fertilized, irrigation) were applied. Samples were taken in June 1995 (the end of the experiment) and the following properties were studied:

1. Length of the main shoot.
2. Length of secondary shoot.
3. Fresh and dry weight of main shoot and secondary shoot.
4. Length of the fibrous root and wooden root per plant.
5. Fresh and dry weight of leaves and roots per plant.

Cation exchange capacity and mineral constituents of fibrous roots and shoots

Cation exchang capacity of fibrous roots:

The objective of this study was studying relationship between different olive cultivars and cation exchange capacity (C.E.C) of fibrous roots. During an active growth period of the root systems, set of paints each consisted of three young plants (30 months old) from each of the four cultivars .C.E.C. of roots was estimated of plants according to the procedure recommended by [9]. The C.E.C. was calculated as me /100 gm dry root material.

Mineral constituents of leaves, shoots and fibrous roots:

Sample of 0.2 gm dried material were dissolved in 10 ml concentrated sulphoric acid, warmed for 5 minutes to dissolve the constituents, and after becoming cold. 2 ml of digestion mixture (1:1, perchloric ocid and sulphoric acid respectively) were added. The samples were heated again for clearing, diluted with diionized water then transferred quantitatively to 100 ml volume with diionized warer [10]. The contents were saved for analysis of nitrogen, Phosphorus, Potassium, Calcium, Magnesium and sodium as follows:

1- Nitrogen content was determined by modified microkejldahl method as described by [11].
2- Phosphorus content was colormetrically estimated according to the method of [12].
3- Potassium, calcium and Sodium were determined by using flame photometer [13].
4- Magnesium was estimated by an Atomic Absorption Spectrophotometer Pye Unicom Sp 1900 according to [14].

Statistical analysis:

All data were subjected to statistical analysis according to procedures reported by [15]. Treatments means were compared by the least Significant Difference test (L.S.D.) at the 5% level of probability of experimentation.

Results and Discussion

Relationship between cultivars and growth parameters:

Fibrous roots (>2mm) of Agizi Shami plants had the highest values for root length (153.9 gm) , root fresh weight(371.1 /gm) and root dry weight (193.4 gm) , while those of Picual plants had the lowest values for the same parameters (root length, 30.7 m ; root fresh weight 56.2 gm and root dry weight , 29 gm) Table (1) .

For the non fibrous roots (< 2mm coratina plants had the highest value for root length (9.3 m), while Manzanillo had the shortest (3m). Moreover, non fibrous roots of Agizi Shami plants had the highest values for root fresh weight and root dry weight (973.8 and 729.4 gm respectively), while the reverse was true with respect with Picual cultivar whereas it produced the lowest non fibrous root fresh weight (167.8 gm) and dry weight (133.3 gm).

Table 1: Relationship between different olive cultivars and shoot growth parameters

Cultivars	Root system					
	Fibrous root > 2 mm.			Fibrous root < 2 mm.		
	Length (m)	Fresh weight	Dry weight	Length (m)	Fresh weight	Dry weight
Coratino	42.4	94.8	42.5	9.3	685.4	472
Picual	30.7	56.2	29.9	3.4	727.7	477.6
Manzonillo	122.7	371.1	107.6	3	167.8	133.3
Agizi Shami	153.9	371.1	193.4	5.9	973.8	729.4
L.S.D. at 0.05	41.42	75.46	63.2	1.82	320.76	290.93

Regarding the stem , it was found that Agizi Shami plants had the tallest stem (3.43 m) , while coratina cultivar had the shortest one (2m) . However, Picual plants had the highest values for stem fresh weight and dry weight (1054.3 and 784.1 gm respectively) while stem weight of Manzanillo had the lowest value either for fresh or dry weight (175.1 gm and 105.8 gm respectively) Table(2) .

Table 2: **Relationship between different olive cultivars and root system parameters**

Cultivars	Vegetative growth							
	Stem			Branches			Leaves weight	
	Length (m)	Fresh weight	Dry weight	Length (m)	Fresh weight	Dry weight	Fresh weight	Dry weight
Coratino	2	396.2	282.7	122.4	731.6	408.5	910	629.7
Picual	2.9	1054.3	784.1	42.2	607	377.7	853.7	3669.7
Manzonillo	2.97	175.1	105.8	27.87	303.3	200.7	300.9	182.1
Agizi Shami	3.43	517.5	325.6	65.2	0.39	413.8	514.4	305.8
L.S.D. at 0.05	0.89	178.9	176.72	16.72	207.7	139.8	231.323	213.52

Results of the current study indicated that branches of coratina cultivar had the tallest branches (122.4) and the highest value for fresh weight (731.6 gm), while branches of Agizi Shami cultivar had the heaviest dry weight (413.8 gm). However, the reverse was true in respect with Manzanillo cultivar, whereas it produced the shortest branches (27.87m) and lightest fresh weight (303.3 gm) and dry weight (200.7 gm). The results in table (2), showed also that leaves of coratina plants had the highest values for leaves fresh weight (910 gm) and dry weight (629.7 gm), while leaves of Manzanillo plants had the lowest values for the same parameters (300.9 and 182.1 gm for fresh and dry weight respectively). However, the differences obtained in response to the effect of cultivars on all parameters under study were statistically significant.

Plant mineral constituents and cation-exchange capacity:

Data concerning leaf, branch and root mineral content as affected by cultivar are presented in table (3). Generally the obtained results showed that leaves contained the highest content of N followed by shoots, then roots in descending order. Taking the specific effect of cultivar into consideration, insignificant differences were detected; however Manzanillo cultivar leaves relatively had the highest N content (2.74%), while Agizi Shami roots had the lowest N content (0.88%). Concerning the plant P content, it was noticed that the leaves had the highest content of P than those of branches and roots for all cultivars except coratina cultivar where the content of P in branches was higher than in leaves and roots. The leaves of Manzanillo had the highest percentages (0.29%), while root of Agizi Shami represented the lowest content (0.13%).Regarding the plant content of K, it is obvious that the accumulation of K in leaf tissues was significantly higher than that in both branches and roots for all cultivars except coratina cultivar where the K content was higher in roots than in leaves and branches. The leaves of Manzanillo cultivar contained the highest K content (0.99%), while the lowest content was in coratina branches (0.65%). Data also showed that the differences due to cultivar response were only significant with K shoot content while such differences with respect with either leaves or roots did not attain the statistical significant level. In assessing total Ca and Mg content in different plant organs (leaves, shoots and roots) of all the studied cultivars, generally, the data showed that roots had the highest content than the other two organs. The roots of coratina had the highest content of Ca (1.86%) where the lowest content was in branches (1.06%), while leaf content ranged from 1.12 to 1.44%. Roots of Manzanillo cultivar had the highest percentage of Mg (0.67%), however Picual branches had the lowest Mg content (0.37%). The differences between cultivars were significant in respect with their shoot and root Ca content, while the results cleared that leaf Ca content was not significantly affected by cultivars. In addition there were no considerable differences between cultivars concerning Mg content in their different plant organs (leaves, branches and roots).The results showed also that plant Na content in different plant organs differed according to cultivar response, where Picual and coratina cultivars contained higher amount of Na in root tissues, while with Manzanillo and Agizi Shami cultivars the highest percentages of Na were in leaf tissue. Moreover, leaves of Manzonillo had the highest Na content (1.74%), while coratina leaves had the lowest ones (1.21%). Generally, the plant organs constituents of mineral elements were differed by cultivars. This conclusion is in harmony with the findings of [4] on olive trees, and Castle and [16] on citrus trees. They showed that mineral content varied with cultivar, indicating a differential ability of cultivar to obtain mineral elements from the soil.

Table 3: Shoot, Leaf and root mineral constituents in different olive cultivars

Cultivars	Shoot						Leaf						Root					
	N %	P %	K %	Ca %	Mg %	Na %	N %	P %	K %	Ca %	Mg %	Na %	N %	P %	K %	Ca %	Mg %	Na %
Coratina	1.51	0.22	0.65	1.06	0.40	1.13	2.35	0.17	0.72	1.12	0.41	1.21	1.06	0.17	0.77	1.86	0.64	1.52
Picual	1.42	0.18	0.75	1.27	0.37	1.42	2.35	0.20	0.77	1.26	0.39	1.51	1.08	0.15	0.81	1.68	0.49	1.67
Manzanillo	1.35	0.20	0.92	1.10	0.41	1.73	2.24	0.29	0.99	1.13	0.42	1.74	1.00	0.16	0.86	1.15	0.67	1.66
Agizi Shami	1.07	0.18	0.78	1.20	0.41	1.42	2.49	0.22	0.77	1.44	0.48	1.56	0.88	0.13	0.89	1.84	0.61	1.33
L.S.D.at (0.05)	N.S	0.076	0.177	0.215	N.S	0.191	N.S	0.091	N.S	N.S	N.S	0.165	N.S	0.025	N.S	0.574	N.S	0.148

Dealing with cation-exchange capacity (C.E.C) , the existed fibrous roots data (Table 4) showed that coratina cultivar had the highest value (4.5 me/100 g dry weight) , while those of Picual had the lowest value (1.9 me / 100 g dry weight) . Fibrous roots, of Manzanillo and Agizi Shami had intermediate C.E.C. value (2.1 and 3-3 me/ l00g dry weight respectively). In addition results of C.E.C indicate significant differences exist between the studied cultivars. Smith and Wallace (1956) using the electro dialysis technique, reported a generally higher fibrous root C.E.C values (ranged from 40 to 54 me/ l00g dry wt.) for different citrus cultivars. Differences between C.E.C values obtained herein and in their study are through to be due to different technique.

Table 4: Cation exchange capacity (C. E. C.) of different olive cultivars fibrous roots .

Cultivars			
Coratina	Picual	Manzanillo	Agizi Shami
(C. E. C.) me / 100 gm dry wt.			
4.5	1.9	2.1	3.3

L.S.D. (0.05): 0.905

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