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Research article

Effect of olive cultivars and date of observation on rate of growth of fibrous roots and shoots

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Abstract

This investigation was conducted during 1993 – 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. 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, Koratina, Manzanillo and Agezi Shami. Olive plants were planted in above-ground rhiziotrons. Pllastic barrels rhizotrons were 50 cm in diameter and 90 cm depth were and filled with sand and clay (8:1 by volume). Samples were taken in June 1995 (the end of the experiment) and the following properties were studied (Length of the main shoot, length of secondary shoot, fresh and dry weight of main shoot and secondary shoot, length of the fibrous root and wooden root per plant, fresh and dry weight of leaves and roots per plant. The studied seasonal periodicity of the shoot and fibrous root growth rate of Koratina, Picual, Manzaniilo and Agizi Shami cultivars showed that shoot and root growth cycles differed in number according to the cultivars since it was 2 to 6 cycles during the study period and the cycle period lasted 3 to 8 months.

Picual had the highest shoot growth rate (3.54 cm/day), while the Agizi shami cultivar had the lowest growth rate (1.99 cm/day) Koratina and Agizi Shami cultivars had 5 growth cycles of shoot system, whereas Picual cultivar exhibited 4 growth cycles while, Manzaniilo cultivar disclosed 3 growth cycles. The greatest growth period of shoot system was in summer. Manzaniilo cultivar had the highest fibrous root growth rate (6.12 mm/day), while the Agizi Shami cultivar had the lowest growth rate (2.31 mm/day). Picual and Agizi shami cultivars showed 5 growth cycles of fibrous root. Whereas, Koratina 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.

Key words: Olive cultivars, rate of growth, fibrous roots.

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1. Introduction

Root growth, especially fine root production and mortality, is a dominant feature of the belowground ecosystem where trees are present [1]. In arboriculture and urban

forestry, the question "When do tree roots grow?" has been largely addressed in the context of transplanting [2-5], where tree establishment depends upon root exploration of the new site [4] and can be influenced considerably by transplant time [6].

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 [7]**.** 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 of some large trees such as Frantoio, although deep rooted, did not have a large root density or length density values, while the small trees of Agizi shamy cultivar had shallow, but dense root systems [8]. Elezaby [9] 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. Major root growth activity for Agizi Shamy was during November and January, while for Picual trees it was during January. Minor activity periods were during May and April for Agizi Shamy, and during February, May, September and October for Picual trees. Frantoio root system activity showed a multi peak pattern during the period of study. Four peaks were observed per season, during October, December, March and June. The seasonal pattern of shoot growth appeared to be generally similar in all cultivars, with major peak during June and smaller one during October. Active root and shoot growth peaks occurred simultaneously. However, peaks of root growth listed longer.

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 the 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 [10].

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.

2. Materials and Methods

This investigation was conducted during 1993 – 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. 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, Koratina, Manzanillo and Agezi Shami. Olive plants were planted in above-ground rhiziotrons. Plastic barrels rhizotrons were 50 cm in diameter and 90 cm and depth were filled with sand and clay (8:1 by volume). The barrels were cut and fit with transparent glass faces 35cm 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

was 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. The number of shoots and roots that were measured on a given plant varied during the experiment due to changes in plant size, shading of shoot terminals, root mortality, growth of roots out of the field of the rhizotrons face and other no controllable factors. Randomly chosen shoot at each rhizotrons in the exterior portions 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 the 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:

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

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. Standard 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.

Statistical analysis procedure

All data were subjected to statistical analysis according to procedures reported by Snedecor and Cochran [11]. Treatments means were compared by the least Significant Difference test (L.S.D.) at the 5% level of probability of experimentation.

3. Results and Discussion

Rates of shoot growth and root growth for young plants (five months old) of Koratina , Picual , Manzanillo and Agizi Shami cultivars were calculated at monthly intervals throughout the two seasons of study (during April, 1993 up to April 1995).

Rate of growth of fibrous root

Significant differences between mean fibrous root growth rate of the cultivars were detected (Table 1). Manzanillo cultivar had the highest root growth rate (6.12 mm/day), whereas Agizi Shami cultivar showed the slowest growth rate (2.3 mm/day), Koratina and Picual cultivars had medium rates (4.12 and 4.01 mm/day respectively). In addition the data obtained indicated significant effects due to date of observation and to the interaction between cultivar and date of observation. Picual and Agizi Shami cultivars had five growth cycles during the/period of the study. The major peak root growth of Picual cultivar occurred during April in both seasons. However, throughout the first season (1993-1994) two additional medium peaks were

presented, one in May and the other in September, while in the second season (1994-1995) there was a small peak in November (Figure 1). Regarding Agizi Shami cultivar it had a major growth peak during June, 1993 and three minor growth peaks occurred during November, 1993, April, 1994 and October, 1994, as well as a small growth peak during April, 1993 (Figure 2). Koratina cultivar had six growth peaks during the two seasons of/study which were represented in two major growth peaks during April, 1993 and 1995 and four minor growth leaks during January, 1994 and 1995, March, 1994 and August, 1994 (Figure 3).

Table 1. Relationship between different olive cultivars and growth rate of fibrous roots (mm/day)

Observation date	Cultivars				Mean fibrous root growth/month
	Koratina	Picual	Manzanillo	Agizi shami	
	Growth rate of fibrous roots (mm/day)				
April 1993	7.28	3.67	0.00	0.72	2.22
May	7.335	5.67	2.78	5.56	5.33
June	5.33	4.06	3.94	8.33	5.41
July	4.22	4.33	5.56	4.50	4.43
August	3.89	2.22	9.87	3.44	4.85
Sep.	2.00	9.11	7.72	4.33	5.79
Oct.	0.00	4.50	1.91	0.00	1.60
Nov.	0.00	0.78	6.05	5.67	3.30
Dec.	2.67	0.33	7.39	1.39	2.94
January 1994	2.72	3.11	5.44	1.70	3.24
Feb	1.39	7.83	11.17	1.05	5.36
March	3.89	4.67	14.39	0.33	5.82
April	2.61	13.11	10.33	4.39	7.61
May	1.61	2.22	5.06	2.17	2.76
June	0.00	2.67	2.78	2.17	1.90
July	0.00	2.89	5.22	2.33	2.61
August	3.44	2.83	4.33	2.00	3.15
Sep.	1.39	1.00	5.89	1.39	2.42
Oct.	0.00	1.11	4.72	2.22	2.01
Nov.	1.00	3.00	3.11	1.50	2.15
Dec.	1.44	1.11	5.00	0.60	2.04
January 1995	3.66	1.67	7.67	1.06	3.15
Feb	1.00	0.00	6.33	0.44	1.94
March	5.56	4.17	6.33	0.00	4.01
April	10.00	15.56	10.00	0.44	9.00
May	7.50	7.00	5.56	3.72	-
Cultivar means	4.21	4.01	6.12	2.31	-

Cultivar = 0.324
L.S.D. (P = 0.05) = 1.162
Interaction =1.976

As for Manzanillo cultivar four growth peaks during study were observed, where the major growth peak was present during March, 1994, while three minor growth peaks occurred during August, 1993, January, 1995 and April 1995 (Figure 4).

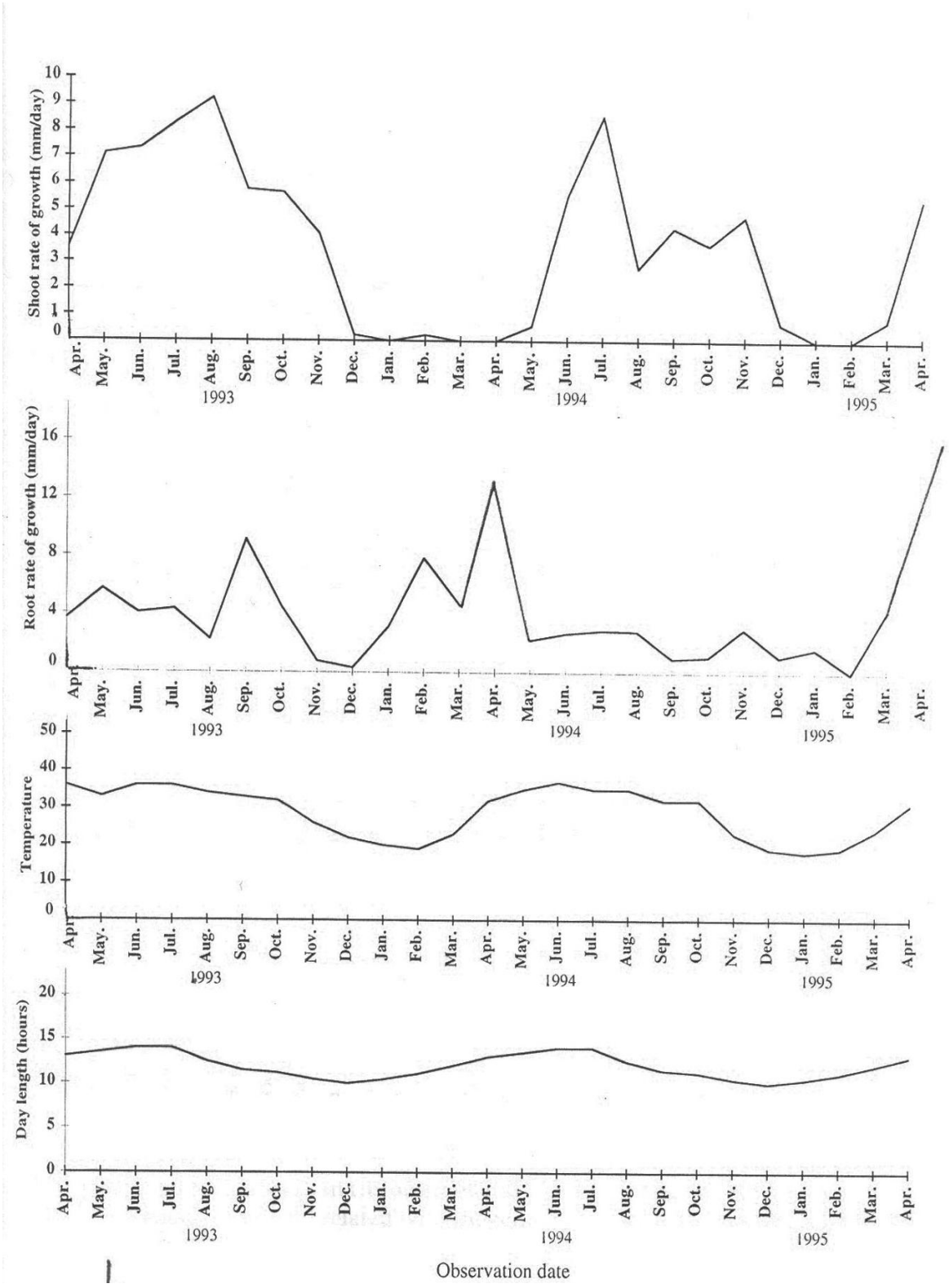

Figure 1. Seasonal changes in fibrous root and shoot growth rates for Picual young plant and related with the temperature and day length.

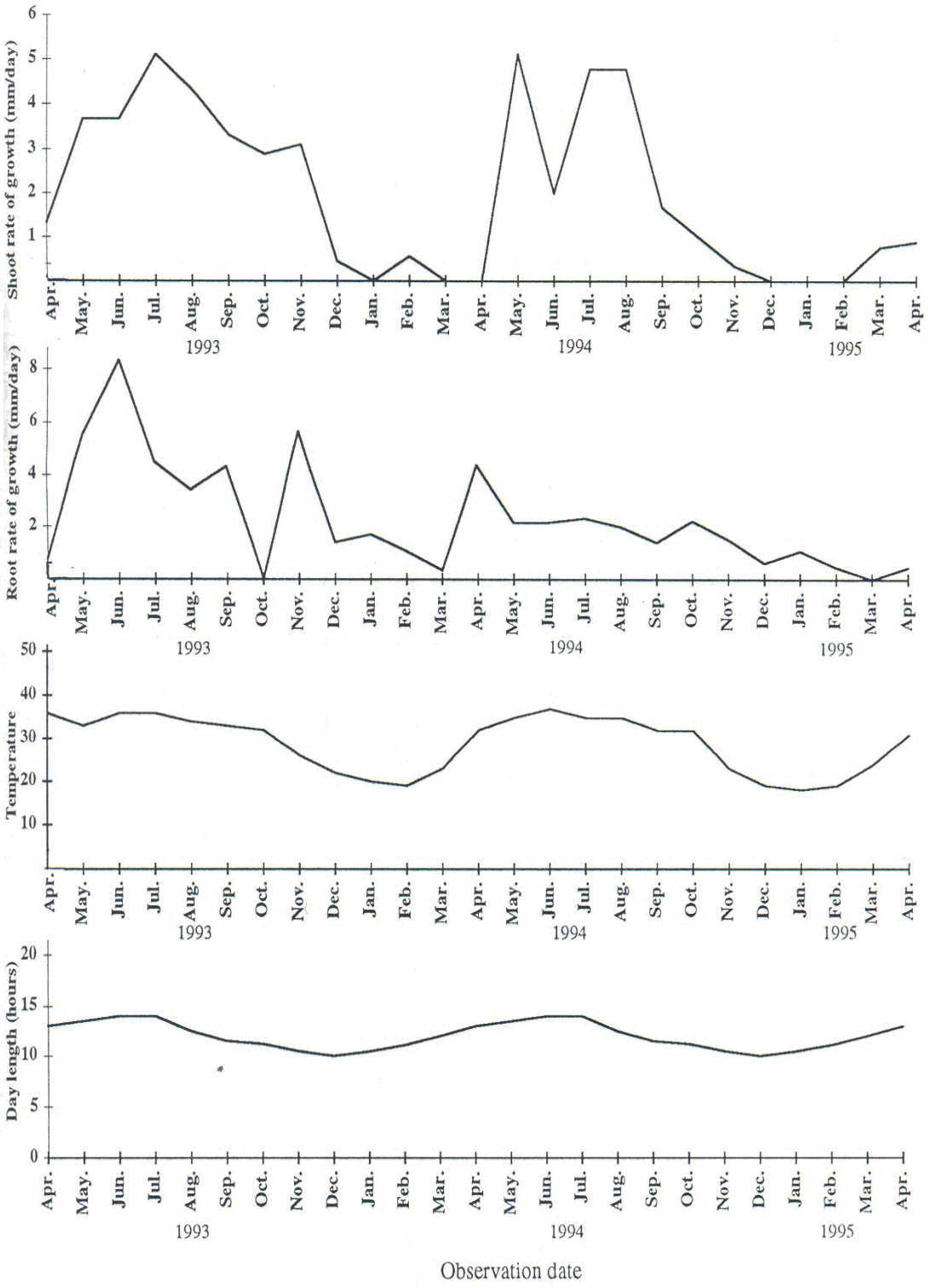

Fig. (2): Seasonal changes in fibrous root and shoot growth rates for Agizi Shami young plant and related with the temperature and day length.

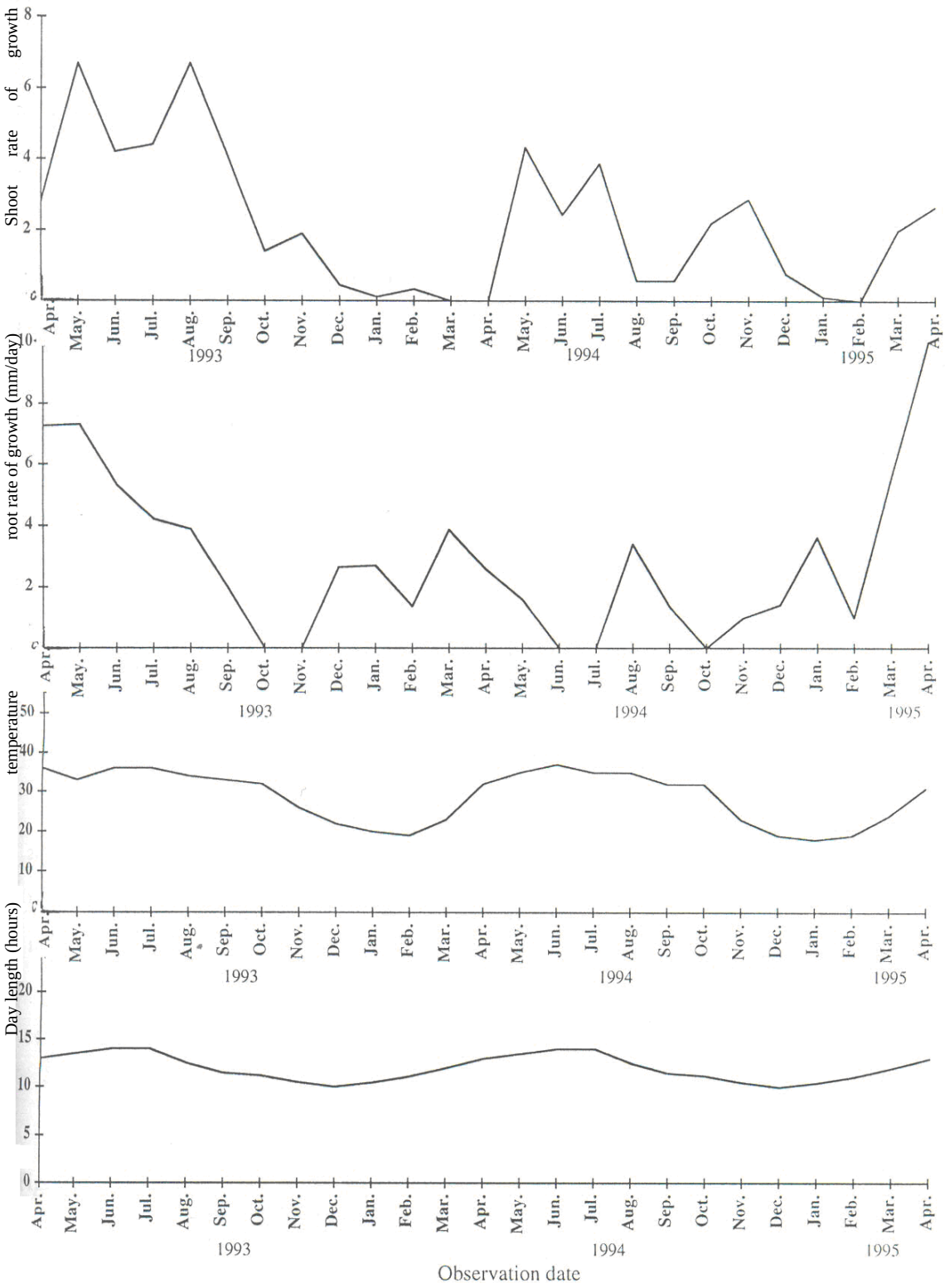

Fig. (3): Seasonal changes in fibrous root and shoot growth rates for koratina young plant and related with the temperature and day length.

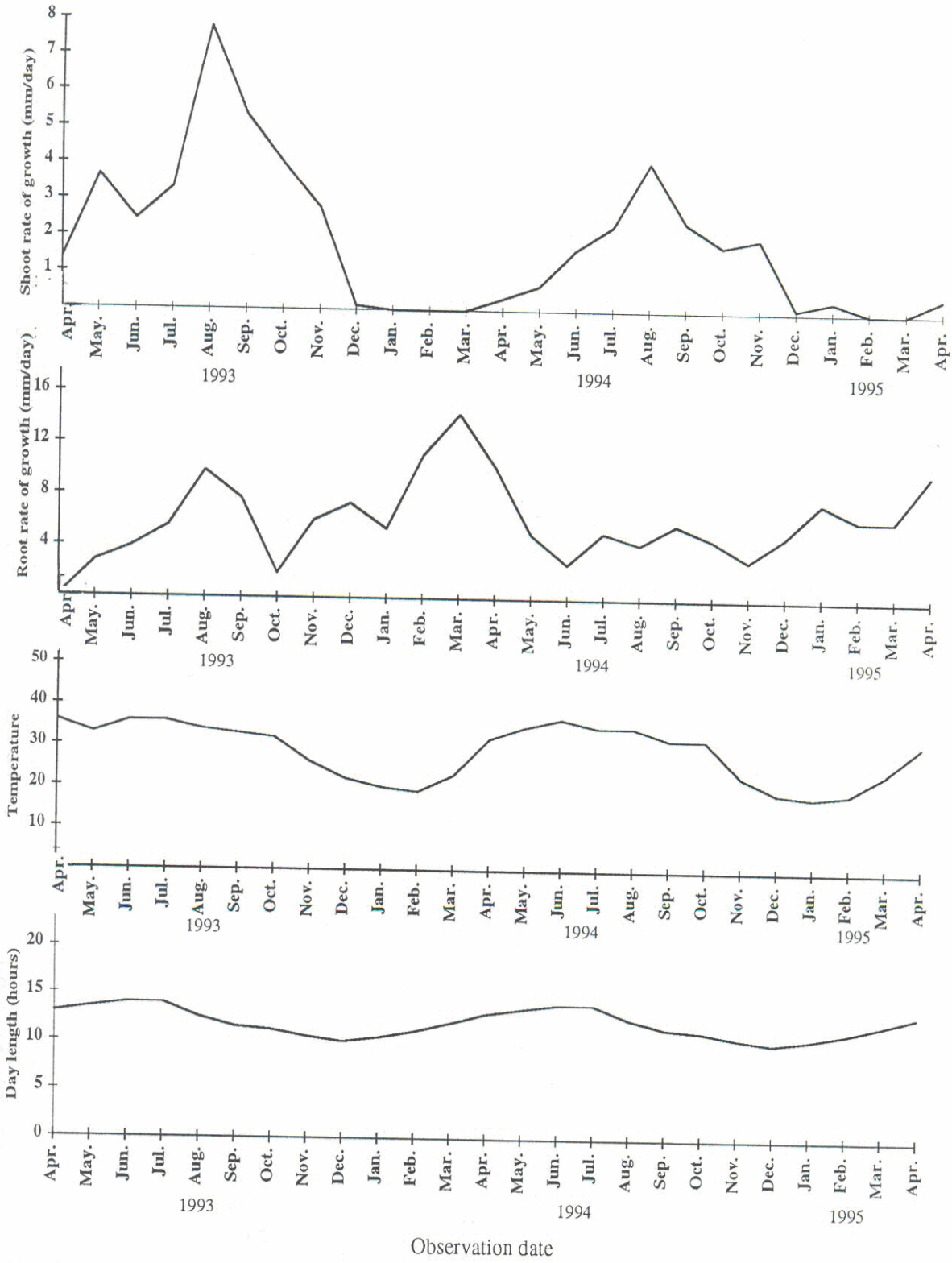

Fig. (4): Seasonal changes in fibrous root and shoot growth rates for Manzanillo young plant and related with the temperature and day length.

Shoots growth Rate

A significant effect was detected for cultivar on mean shoot growth rate during the period of study (Table 2). Picual cultivar disclosed the highest shoot growth rate (3.54 mm/day), whereas Manzanillo and Agizi Shami cultivars represented the lowest one (1.99 mm/day). However, Koratina cultivar had a medium rate (2.22 mm/day). Moreover, significant differences, in the two seasons of study were obtained from the effect of the date of observation as well as the effect of the interaction between cultivar and date of observation. Coratina and Agizi Shami cultivars had five growth peaks during the period of study. The major peak of Koratina shoot growth occurred during May, 1993. During the second season four additional medium peaks were noticed in (May, 1994; Jule, 1994; November, 1994 and April, 1995), while it had no small peak growth (Figure 3).

Table 2. Relationship between different olive cultivars and growth rate of fibrous roots (mm/day)

Observation date	Cultivars				Mean fibrous shoot growth/month
	Koratina	Picual	Manzanillo	Agizi	
	Growth rate of fibrous shoot (mm/day)				
April 1993	2.80	3.56	1.33	1.33	2.25
May	6.70	7.11	3.67	3.67	5.29
June	4.20	7.33	2.44	3.67	4.41
July	4.44	8.33	6.33	5.11	6.05
August	6.70	9.22	7.78	4.33	7.01
Sep.	4.10	5.78	5.33	3.33	4.63
Oct.	1.44	5.67	4.00	2.89	3.50
Nov.	7.90	4.10	2.78	3.11	2.97
Dec.	0.44	0.22	0.11	0.44	0.41
January 1994	0.11	0.00	0.00	0.00	0.03
Feb	0.33	0.22	0.00	0.56	0.07
March	0.00	0.00	0.00	0.00	0.00
April	0.00	0.00	0.33	0.00	0.08
May	4.33	0.56	0.67	5.11	2.67
June	2.44	5.56	1.67	2.00	2.92
July	3.88	8.56	2.33	4.78	4.88
August	0.56	2.78	4.10	4.78	3.05
Sep.	0.56	4.33	2.44	1.67	2.25
Oct.	2.21	3.67	1.79	1.00	2.17
Nov.	2.89	4.78	2.00	0.33	2.50
Dec.	0.76	0.67	0.11	0.00	0.36
January 1995	0.11	0.00	0.33	0.00	0.11
Feb	0.00	0.00	0.00	0.00	0.00
March	2.00	0.78	0.00	0.77	0.89
April	2.67	5.44	0.44	0.89	2.36
May	0.00	0.56	0.89	2.00	0.86
Cultivar means	2.22	3.54	1.99	1.99	--

L.S.D. Cultivar = 0.201
Date = 0.913
Interaction = 2.034

Major shoot growth activity for Manzanillo occurred during August, 1993. Manzanillo cultivar had one minor peak during August, 1994, while a small peak of growth was observed during April, 1995 (Figure 4). With respect to Picual cultivar four growth peaks during the two seasons of study were recorded which were represented in major peak shoot growth occurred during Jule, 1993 and 1994, a minor peak growth during November, 1994 and a small peak during April, 1995 (Figure 1). Concerning Agizi Shami the major peak of shoot growth occurred during July, 1993 and 1994, and May, 1994 (Figure 2). Small peaks were detected during February, 1994 and April, 1995, while it had no minor peaks.

Alternate growth pattern of shoot and root cycles were generally present during both seasons of study (Figure 1 to 4). During the first season shoot growth preceded root growth for Manzanillo and Agizi Shami cultivars, while the growth of both roots and shoots occurred simultaneously for Picual and Manzanillo cultivars. During the second season root growth preceded shoot growth in all cultivars.

Results obtained from the present study showed that major periods of the shoot and fibrous root growth for all cultivars generally occurred during the summer time. Similar findings were obtained by Elezaby [9] who reported that active shoot and root growth peaks for Agizi Shami, Picual and Frantoio olive trees occurred during the summer.

Four to six fibrous-root growth cycles of young olive plants were observed for all studied cultivars, while the shoot system had three to five growth cycles during the period of study. This conclusion is not in harmony with the findings of Elezaby [9] that showed that root growth cycles of olive trees during the period of his study ranged from two to four growth cycles according to cultivars, while shoot system had two growth cycles for all the studied cultivars. For other fruit tree species (i.e. citrus) there was two to three fibrous-root growth cycles were previously observed for citrus plants, and as well as the shoot system the major periods of growth were observed during the summer [12-13]. In the present study, there were periods where alternation of root growth and shoot growth existed, but generally the growth of both parts occurred simultaneously. However, peaks of root lasted longer. Results of this study support the findings of Elezaby [9] on olive trees; Snedecor et al. and Bevington et al.[12-13] on citrus trees and Richardson et al. [7] on different tree species, they suggested that root and shoot systems grow simultaneously.

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