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# EFFECT OF ROOT-PROMOTING SUBSTANCES AND DATE OF PLANTING ON BOOTING OF OLIVE CUTTINGS

Ву

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OLIVE PROPAGATION

KHAN

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#### ABSTRACT

Rooting of softwood cuttings of the olive variety "Chatawi" was examined at the American University of Beirut. Cuttings were taken at twenty regular fortnightly intervals starting on July 21, 1963. They were treated with solutions of root-promoting substances and were planted in vermiculite and provided with bottom heat at 20 to 22C.

Callusing was retarded but faster and higher percentages of rooting were obtained when the cuttings were taken during the winter and spring months and were treated with solutions of root-promoting substances. Among these substances, IBA at 3000 ppm gave the best results.

Treatment with IBA at 3000 ppm also gave significantly higher percentage of well-rooted cuttings. Cuttings treated with methylene blue at 25 ppm gave the lowest percentage of callusing and rooting.

Mortality of cuttings was high when plantings were made during July or August. Untreated cuttings or cuttings treated with IBA at 3000 ppm had the least mortality as compared with that of the cuttings treated with IBA at 5000 ppm or NAA at 4000 ppm.

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#### INTRODUCTION

Rooting of olives (<u>Olea europea</u> L.) by cuttings is highly important for the production of clonal scion varieties and uniform stocks for budding or grafting. Cuttings from many olive varieties are, however, difficult to root without any treatment such as the use of a root-promoting substance.

Recently in plant propagation trials in the United States of America and elsewhere a number of growth regulators have been shown to promote rooting of cuttings (7). In addition it appears that cuttings of many olive varieties root fairly well in clean sharp sand, especially with bottom heat and high humidity, provided attention is given to other factors such as proper timing in obtaining the cuttings (16).

Work on similar lines has not been reported so far from the Middle East.

Olives play an important role in the economy of most Middle Eastern countries. In Pakistan, schemes for establishing large scale olive plantations are under government consideration with a view of producing enough olive oil to meet the acute shortage of edible oils and fats in the country (18).

The expected vast expansion in the area under olives in the Middle East warrants the establishment of sound methods for rapid multiplication of improved varieties. The

present investigation has been, therefore, concerned with determining an efficient and economical method for rooting olive cuttings by utilizing the most recent and advanced techniques.

#### REVIEW OF LITERATURE

Many different types of cuttings have been used for propagating olives but the use of leafy shoot cuttings has been found to be the most promising (7). According to Elant and Perrot (9) 100,000 olive trees are propagated annually by softwood cuttings for the "Beni Amir" (Algeria) irrigation area. In California a large proportion of the olive trees produced each year are propagated by softwood cuttings (13).

A number of synthetic growth regulators aid the rooting of cuttings (11). The two now in common use are Beta-indole-butyric acid (IBA) and Alpha-naphthalene-acetic acid (NAA) either in their acid forms or as salts.

Evenari and Konis (10) treated dormant cuttings of olive, fig and vines with Beta-indole-acetic acid (IAA) in solutions or in lanolin pastes. The effectiveness of the treatments in inducing root formation was shown to depend on the method of application. They found that treatment of the basal portion of the cuttings minimized inhibition of bud development. For leafy cuttings the solution method was superior to the lanolin paste method; the latter when applied to the base of the cutting, hindered the up-take of water with consequent wilting. In certain cases a better rooting response was obtained by the addition of sugar to the solutions.

The method of application of root-promoting substances used by Hitchcock and Zimmerman and described by Cooper (8) consisted of dipping the bases of the cuttings for a few

seconds in a 50% alcohol solution containing I to 20 mg/ml of the root-promoting substance. This method was found particularly effective with such difficult-to-root species as apple and rhododendron. The large volume of alcohol used in these concentrated solutions made the method helpful in preparing solutions of some of the relatively insoluble compounds such as naphthalene acetamide.

Hartmann (14), working on olive propagation, found that the concentrated-solution-dip method of applying root-promoting substances was almost as satisfactory as the low-concentration-soaking method in rooting softwood olive cuttings. While IBA at 4000 to 5000 ppm gave the best results in the concentrated-solution-dip method almost as good results were obtained in concentrations ranging from 3000 to 7000 ppm. In comparisons made using vitamin BI as a preplanting treatment, no benefits were obtained from this material with hardwood olive cuttings.

Dipping the bases of softwood cuttings, 9 to 12 cm long, of the olive variety Mission in concentrated solutions of either IBA (2g/1) or a combination of IBA and NAA (each at 0.5g/1) resulted in 14% and 34% rooting respectively, as compared to the untreated controls (4). Additional treatment with ammonium sulphate and sucrose had no beneficial effect.

Hartmann and Hansen (16) tested the Sevillano olive

for its rooting ability under mist. It proved to be relatively easy to root provided attention was given to other factors, such as proper timing in obtaining the cuttings and the use of root-promoting substances. Of the treatments employed, the use of root-promoting substances was the most important.

When cuttings of an olive variety of poor rooting quality were treated with different root-promoting substances, there was no increase in rooting over the water control. However, there was more root growth and number on cuttings treated with NAA (2).

Rooting in eight olive varieties ranged from 3% in Coratina and 3.3% in Leccino to 49.4% in Maurino (19). The treatments were comprised of IBA and IAA each at I0,50 and IOO ppm and vitamin B6 at I0,30 and 60 ppm. With a single exception, the highest rooting percentages (29.4 - 67.1%) were obtained with IOO ppm IBA. The differences in varietal responses to the three substances were considerable. In general, callus formation and shoot growth were not affected by the treatments.

The application of a I:I,000 aqueous solution of methylene blue, for 30 minutes, stimulated the formation of roots and general growth of hop (<u>Humulus lupulus</u>) cuttings (3). The roots of the treated cuttings were four times longer and contained up to 31% greater substance than the controls.

Hartmann (14) reported that, in rooting softwood cuttings of the clive, the use of sand as a rooting medium resulted in a long, unbranched type of root, whereas several mixtures of other materials gave a more desirable, compact, branching type of root system. A good mixture was found to be one made of vermiculite plus Haydite.

Experiments to show the effect of the rooting media on olive cuttings were made by Blommaert (4) at Stellen-bosch. The best results were obtained with sifted sand alone and with a mixture containing two parts of sand to one part of vermiculite. These gave 70% rooting. Vermiculite alone gave almost as good results.

Reduction in rotting and improvement in rooting occurred when vermiculite was used instead of sand for rooting cuttings, treated with root-promoting substances, under constant mist (21).

Olive cuttings of the variety Leccino rooted best in medium-size-grained vermiculite (5). Results were also good with coarse or fine vermiculite and with sphagnum moss or building sand, but fine sea sand was not satisfactory.

Depth of planting cannot properly be considered apart from the length of the cutting. According to Garner's report (11), Casella, working with olives, used short thick hardwood cuttings which were planted either horizontally or vertically 6 to IO cm below the surface. By slanting the

cutting the depth of planting was adjusted without exposing un-necessary above ground length.

Stcherbakoff (22) discussed the respective merits of propagating olives from seeds or cuttings. He suggested that the one-or two-year old cuttings must be 8 to 9 cm long with 3 to 4 buds, the leaves must be removed from the lower two buds and the cuttings set to a depth of two-thirds of their length, leaving one or two buds above the sand.

According to Garner (11) Knight found that a high water content of the medium favored callusing but reduced rooting in hardwood cuttings. However, he quoted Hunter who reported indications that root formation, as distinct from callusing, took place under fairly wet conditions. Hunter recommended increasing the water supply of the media after callusing.

Hartmann (13,14) observed that in general better results were obtained when bottom heat, controlled at 23C.was used together with high humidity in rooting softwood cuttings of olive.

Success in the application of root-promoting substances to cuttings was found to depend on optimum environmental conditions (20). At 20 to 25C results were much better than at lower temperatures in propagating chrysanthemums by cuttings, treated with the preparation P604. (The chemical compound not stated). Low levels of moisture in the medium induced better rooting than high levels.

Anzilotti (1) was able to root olive cuttings fully in 60 to 90 days, without the removal of any leaves, by keeping the substrate temperature maintained at 22 to 26C and the relative humidity at 60 to 85%. The percentage of success ranged from 70 to 90 in lignified and 30 to 60 in softwood cuttings.

The time at which cuttings are to be taken, is apparently, related to the condition of the plant and to the climate rather than to the calender. In England temperate climate hardwood cuttings are prepared and planted in September and October, whereas in parts of North America they are collected in the autumn, stored during the winter and planted in the spring (11).

Tukey and Brase (23), working in New York with apple found that those taken in autumn and stored until spring rooted better than cuttings taken and planted in the spring.

Untreated olive cuttings formed roots more readily when taken in the fall and winter months than in late spring (13). When root-promoting substances were used very good results were obtained with cuttings taken in the spring.

#### MATERIALS AND METHODS

Rooting of cuttings of the olive variety "Chatawi" was examined using softwood cuttings taken at different times of the year and treated with root-promoting substances before planting. Cuttings were obtained from six bearing trees growing on the campus of the American University of Beirut that received pruning, fertilizer and one summer irrigation. The terminal 12 to 15 cm leafy shoots were removed from the harvested branch and discarded and cuttings approximately 10 cm long and 1 to 1.5 cm thick were made of the remaining material with a sharp pruning secateur. Only mature wood of the latest growth (Fig. 1A) was employed. The cuttings were wrapped in a moist towel during their handling to keep them from desiccation.

Before planting, all leaves from the cuttings, except the uppermost two, were removed. The cuttings were treated with a number of root-promoting substances in different concentrations. The treatments were applied using the concentrated-solution-dip method as described by Cooper (8).

Planting was carried out in flats of vermiculite. The cuttings were set 6 cm deep and 2.5 cm from one another, in rows 4 cm apart. In all, twenty plantings were made at regular fortnightly intervals starting on July 21, 1963.

During the winter and spring months from the 18th of October 1963 to the 15th of June 1964 the flats were placed in a thermostatically controlled electric heated bed with a bottom temperature ranging from 20 to 24C. During the rest of the period the flats were kept outside the hot bed.

Water was sprinkled over the cuttings as and when required. The cuttings remained in the flats for a period of 90 days after which the experiment was terminated.

The experiment was laid out on a randomized block system in which there were eight treatments (root-promoting substances) and twenty blocks (planting dates). The treatments were as follows:

1.	Control
2.	2,4-Dichlorophenoxy acetic acid (2,4-D)200 ppm.
3.	3-Indole butyric acid (IBA)3000 ppm.
4.	3-Indole butyric acid (IBA)5000 ppm.
5.	Nutrient solution consisting of:
	Water 1000 CC.
	Sucrose 5000 ppm.
	Urea 1000 ppm.
	Thiamin 25 ppm.
	Nicotinic acid 25 ppm.
6.	Nutrient solution plus IBA at 3000 ppm.

Tetra methylthionin chloride (Methylene blue) .... 25 ppm.

Each treatment consisted of 20 cuttings.

7.

## The twenty planting dates were as follows:

1.	July 21, 1963	11.	December 21, 1963
2.	August 6, 1963	12.	January 6, 1964
3.	August 21, 1963	13.	January 21, 1964
4.	September 6, 1963	14.	February 6, 1964
5.	September 21, 1963	15.	February 21, 1964
6.	October 6, 1963	16.	March 6, 1964
7.	October 21, 1963	17.	March 21, 1964
8.	November 6, 1963	18.	April 6, 1964
9.	November 21, 1963	19.	April 21, 1964
10.	December 6, 1963	20.	May 6, 1964.

Treatments 2 and 7 were dropped from the experiment as of March 6, 1964 on account of shortage of cuttings and the relatively poor performance of these treatments.

The cuttings were examined 30, 45, 60, 75 and 90 days after being placed in the rooting medium for callusing, rooting and survival. Cuttings were considered as callused when callus formation was observable (Fig. 1 B). Rooted cuttings were classified as well-rooted or poorly-rooted according to the number of roots formed and the length attained by them. Only the cuttings that formed at least three roots five centimeters long were classed as well-rooted (Fig. 1 C & D). After every observation the cuttings were replanted discarding the well-rooted and dead cuttings.

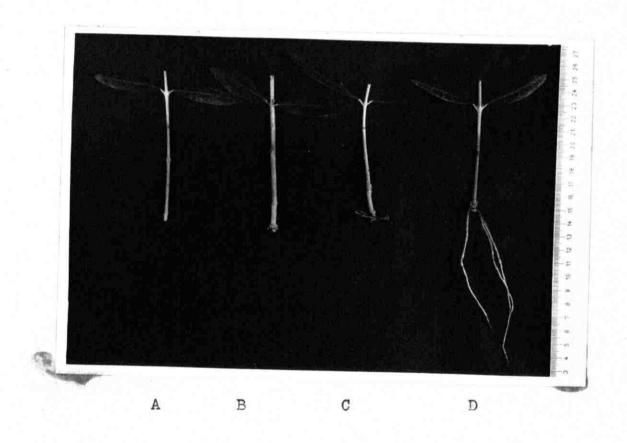


Fig. 1. Softwood olive cuttings before planting (A), after callusing (B), poorly-rooted (C) and well-rooted (D).

#### EXPERIMENTAL RESULTS

The results obtained from the rooting of softwood leafy cuttings of olives are reported in tables 1 to 20. The analysis of variance for each character studied is given in the appendix in tables 22 to 25. The experimental findings are reported in three sections, namely callusing, rooting and mortality.

#### Callusing:

Both time required for callusing and percentage of cuttings callused were affected by planting dates and growth regulators. As seen in tables 1 to 5 callusing started earlier on cuttings planted in mid-summer (July and August) and early spring (February). The above cuttings had the highest amount of callusing 45 days after planting. As rooting time advanced differences in percentage of callusing due to planting dates gradually decreased. After a period of 90 days the highest mean percentages of callusing (30.0 to 33.33% - Table 5) due to planting dates were found on winter and early spring (December 21 to February 21) planted cuttings.

All growth regulators except methylene blue produced faster and higher callusing than the control throughout the period under observation.

Of the growth regulators IBA at 3000ppm and 5000ppm and IBA at 3000ppm with nutrient solution produced faster and higher callusing than the rest of the growth regulators.

The highest percentage of callusing (29.5%) resulted from

the 3000 ppm IBA treatment followed by IBA at 3000 ppm plus nutrient solution (18.25%) and IBA at 5000 ppm (17.0%).

Two of the chemicals, 2,2,4-D and methylene blue, produced significantly lower callusing percentages than the rest of the growth regulators. The mean percentage of callusing obtained with 2,4-D in 90 days was 10% and with methylene blue only 3% which was appreciably less than the control (5.0%). With this in view these two treatments were discontinued as of March 6, 1964 when the supply of cuttings ran short.

## Rooting:

As shown in tables 6 to 10 there was no rooting during the first 30 days after planting the cuttings, irrespective of the planting dates and treatment with growth regulators.

Rooting started earlier with cuttings planted in late winter (January 21) and early spring (February 21). Percentage of rooting increased under all treatments as time advanced. As shown from the means of planting dates in table 10 the highest rooting percentages (29.16 to 14.16%) were obtained in 90 days after planting during the period from December 21, 1963 to April 6, 1964.

In general, all growth regulators produced faster and higher percentages of rooting than the control. IBA at 3000 ppm

Percentage of Softwood Olive Cuttings, 30 Days after Planting. Effect of Planting Dates and Growth Regulators on Callusing -Table

Planting			Growth	n Regulators			Mean of
Dates	Control	IBA 3000ppm	IBA 5000ppm	Nutrient Solution	Nutrient Plus IBA 3000ppm	NAA 4000ppm	Surround to
9.6.	C	25	2	2	30	0	9.16
0	יעי	120	07.	Mn	27,5	2,22	10,10,10,10
	00	ço.	70	700	) O (	000	00
21.9.63	00	00	00	00	00	00	000
10	0	0	0	00	00	00	00
4:	00	00	00	00	00		00
6,12,63	00	0	0	0	0 (	00	00
.12.	0	0 (	00	0 (	00	00	00
6.1. 64	00	00	00	00	00	0	0
210	00	10	N	0	0	200	
101	0	25	20.	00	00	00	05.00
6.3.64	00	00	00	00	0	0	0
21.3.04	o c	00	0	0	0	0	0
21.4.64	0	0	0	0	0 (	00	0
6.5.64	0	0	0	0	000	200	
ean of	Growth 0.25	5.50	2.75	0.75	3.00	CZ÷T	
Mean of G	Growth Regulators	tors	5.5	3.0 2.75	1,25 0	0.75 0.25	501
Jo	Planting Dates	50	14.16	10,83	9,16 7,50	3.33	0
	)						
					The state of the last of the l		

Means underlined by the same line do not differ significantly at the 5% level.

Percentage of Softwood Olive Cuttings, 45 Days after Planting. Effect of Planting Dates and Growth Regulators on Callusing Table 2.

Planting Potos	ŧρ		Growth	Regulators			
700000	Control	IBA 3000ppm	IBA 5000ppm	Nutrient Solution	Nutrient Plus IBA 3000ppm	NAA 4000pm	Francing Date
21.7.63		25	5	٧	20	C	
6.8		10	ر ابر	, ,	000	) V	
ω	10	200	17.	) V	2 50	72	14.16
6.9		10	10	10	10	) V	0.83
6	0	0	0	0	0	10	
6,10	3	0	0	0	0	0	0
10.	0	0	0	0	0	0	0
i.		0	0	0	0	0	0
7.7		0	0	0	0	0	0
6,12	3	0	0	0	0	0	0
122		0	0	0	0	0	0
6.1.		0	0	0	0	0	0
	10	55	35	15	0	20	20.00
6.2.	0	77	2	0	0	<i>y</i>	4.16
27.2.64	0	047	040	10	5	10	17.50
9	0	N	0	0	0	2	1,66
3	0	20	0	0	10	0	5.00
4.9	2	20	N	0	15	25	11.66
*	O	0	0	0	10	0	Н
6.5.64	0	0	0	0	0	0	0
Mean of Garana Regulator	Growth 1.00 or	11.50	00*9	2.25	5.25	4.25	
Mean of	Growth Regulators		11.5 6.0	5.25 4.25	2.25	1.0	
Mean of	Planting Dates	20.0	17.5 15.0	14,16 11	6 91.6 99.	0,1 61.66	0.83 0
						-	

Means underlined by the same line do not differ significantly at the 5% level. N.B.

Percentage of Softwood Olive Cuttings, 60 Days after Planting. Effect of Planting Dates and Growth Regulators on Callusing Table 3.

Control IBA IBA Nutrient Nutrient Scholopm 5000ppm 5000ppm 1BA 1BA Nutrient Nutrient Nutrient Scholopm 5000ppm 5000ppm 1BA 1BA Nutrient Scholopm 5000ppm 5000		
7.63 0 25 15 10 10 63 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Nutrient Plus NAA IBA 3000ppm 4000ppm	- Flanting Date
8.63		10,00
8.63 9.63 10.63 10.63 10.63 10.63 10.63 10.63 10.63 10.63 10.63 10.63 10.63 10.63 10.63 10.63 10.64 10.6		00 25
10.63 10 70 40 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		2000
10.63 10 70 40 00 00 00 00 00 00 00 00 00 00 00 00		07.47
10.63 10 70 40 00 00 00 00 00 00 00 00 00 00 00 00	0	0.83
10.63 10 70 40 25 00 10.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		0
10.63 0 40 25 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		23,33
1.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10	10.83
11.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		0
12.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0
12.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0
1.64 15 75 35 0 2.64 0 30 10 0 25 2.64 0 50 40 15 3.64 0 25 25 15 3.64 5 30 25 15 4.64 0 0 0 0 0 0 5.64 0 0 0 0 0 0 5.64 0 0 0 0 0 0	0	0
1.64 15 75 35 25 25 25 64 0 25 46 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	30	22.50
2.64 0 30 10 0 2.64 0 25 15 3.64 5 30 25 4.64 5 25 5 4.64 0 0 0 0 5.64 0 0 0 0		25.03
2.64 0 25 40 15 3.64 5 30 25 15 4.64 5 25 5 0 5.64 0 0 0 0 0	) C	100
3.64 5 30 25 15 0 3.64 5 30 25 15 4.64 5 0 0 0 0 5.64 0 0 0 0 0 of Growth 2.00 23.25 12.50 4.00		28.33
3.64 5 30 25 15 4.64 5 25 5 0 4.64 0 0 0 0 5.64 0 0 0 0		0000
4.64 5 25 5 0 4.64 0 0 0 0 0 5.64 0 0 23.25 12.50 4.00		00-02
74 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		99.91
5.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	200	1,66
of Growth 2,00 23,25 12,50 4,00		0
Regulator	9.75 10.50	
Mean of Growth Regulators 23.25 12.5 10.5 9.75 4.0	4.0 2.0	,

Means underlined by the same line do not differ significantly at the 5% level. N.B.

Percentage of Softwood Olive Cuttings, 75 Days after Planting. Effect of Planting Dates and Growth Regulators on Callusing Table 4.

Control IBA IBA Nutrient Nutrient Plus NAA FIGURE DESCRIPTION DESC	Planting			15	Growin Regulators	S.TOJE			40
63 0 0 25 15 10 20 0 10.00 63 0 0 25 15 10 20 15 15.00 64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Dates		IBA 3000pm	IBA 5000ppm	Nutrient Solution	Nutrient IBA 3000r	us	Fighting D	D
63 5 25 15 10 20 15 14.16  63 0 0 0 0 0 0 0 0  63 0 0 0 0 0 0 0  63 0 0 0 0 0 0 0  64 0 0 0 0 0 0 0  64 0 0 0 0 0 0  64 0 0 0 0 0 0  64 0 0 0 0 0  64 0 0 0 0 0  64 0 0 0 0 0  65 0 0 0 0  66 0 0 0 0  67 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0 0 0  68 0 0  68 0 0 0  68 0 0 0  68 0 0 0  68 0 0 0  68 0 0 0  68 0 0 0	1.	C	25	v	10	20	0	0	
63 0 25 15 5 25 15 16 16 16 16 16 16 16 16 16 16 16 16 16	9.0	) LC	150	L V	10	20	15	0	
653 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	3.6	10	25	15	2	25	15	-	
63 0 5 40 0 15 5 23.33	9.6	0	0	0	0	0	2	ω.	
0.63 10 70 40 0 15 2333 0.63 0 20 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	9.6	0	n	0	0	10	0	n	
0.63 0 40 25 0 0 0 0 0 0.83	10.6	10	202	047	0	15	20	3	
1.63 0 0 0 5 6.68 0 6.66 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10.6	0	94	25	0	0	0	m c	
1.653 0 20 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	11.6	0	0	N	0	0	0	0,	
2.63	11.6	0	20	72	0	0	2	0	
2.63 15 55 45 0 10 22.50 64 15 75 30 15 60 30 30.00 64 15 75 35 25 0 6 30 30.00 64 0 20 20 25 25 0 25 25 83 64 0 20 25 25 20 25 25 25 25 25 25 25 25 25 25 25 25 25	12.6	0	0	0	0	0	0		
64 15 75 30 15 60 30 30 30 00 64 64 15 30 30 30 30 64 64 15 35 35 25 83 64 64 15 35 35 25 83 64 64 15 30 30 20 25 35 35 35 35 64 64 6 25 20 25 25 35 18 33 30 64 64 6 25 25 25 25 25 25 25 25 25 25 25 25 25	12.6	15	55	45	0	10	10		
64 15 75 35 25 35 25 83 25 64 64 64 65 83 25 6.83 25 6	1.64	0	5	30	17	09	30	-	
64 0 30 20 0 15 13.33	H		75	35	.25	0	5		
64 0 50 40 20 25 35 45 30.00 64 0 25 5 20 25 35 18.33 64 0 25 25 20 25 35 18.33 64 0 25 25 25 20 25 20.00 64 0 25 25 25 25 20.00 64 0 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 0 0 64 0 0 0 0 0 0 0 0 0 0 0 0 0 65 83 25 5 0.83	2	0	30	20	0	15	15	-	
64 0 25 5 20 25 25 20 25 20 25 20 00 6.6 5.83 2.5 0.83 2.	21.2.64	0	50	04	20	25	45		
of Growth Regulators 27.75 16.25 14.75 12.25 20 25 20 25 20 25 20 35 20.00 35 16.66 25 30 35 32.5 0.83	6.3.64	0	25	2	20	52	32		
of Growth Regulators 27.75 16.25 14.75 12.25 6.25 2.75 0.83	8	20	30	25	15	20	52.5		
of Growth Regulators 27.75 16.25 14.75 12.25 6.25 2.75 of 30.0 25.83 22.5 20.0 18.33 16.66 15.0 14.16 13.33 10.83 10.0 6.6 5.83 2.5 0.83		N	22	5	0	20	5,		
of Growth Regulators 27.75 16.25 6.25 14.75 12.25 ator of Growth Regulators 27.75 16.25 14.75 12.25 6.25 2.75 of 30.0 25.83 22.5 0.83	+10	00	010	00	v00	000	00		
of Growth Regulators 27.75 16.25 14.75 12.25 6.25 2.75	of	2.75	27.75	16,25	6.25	14.75	12,25		
0f 30.0 25.83 23.33 22.5 20.0 18.33 16.66 15.0 14.16 13.33 10.83 10.0 6.6 5.83 2.5 0.83	Jo	Regulators	27	16,25			2.75		
	4	23	5 20.	18.33	15.0	16 13.33	10.0 6.6	2.5	33 0

Means underlined by the same line do not differ significantly at the 5% level. N.B.

Percentage of Softwood Olive Cuttings, 90 Days after Planting. Effect of Planting Dates and Growth Regulators on Callusing Table

63 5 25 15 10 25 400 0ppm   Solution   TBA 3000ppm   4000ppm   5000ppm   5000ppm   Solution   TBA 3000ppm   4000ppm   4000ppm   5000ppm   5000ppm	Planting 1	,		Gre	Growth Regulators	rs		1	
7.63 5 25 25 10 30 0 12.  8.63 0 25 15 10 25 15 10 25 15 15.  9.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Dates		IBA 3000ppm	IBA 5000ppm	Nutrient Solution	Nutrient Plus IBA 3000ppm	NAA 4000ppm	Flanting Da	υ Ο
8.63 5 25 15 10 25 15 18 10 25 15 18 18 18 18 18 18 18 18 18 18 18 18 18	1.7.	70	25	2	10	30	0	12,50	1
8.63 0 25 15 5 40 25 18 9.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6.8	120	25	15,	10	22	15	15.83	
9.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	I.8.	0	25	15	2	24	25	18,33	
10.63 10 70 40 0 10 0 23.  10.63 10 70 40 0 15 5 23.  10.63 10 70 40 0 15 5 23.  11.63 0 20 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6	0	0	0	0	0	7	0.83	
10.63 10 70 40 0 15 5 23.  10.63 5 45 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.9.	0	2	0	0	10	0	2.50	
10.63 5 45 20 0 0 0 0 11.  11.63 0 20 15 0 0 0 0 0 0 0.  12.63 0 20 15 0 0 0 0 0 0 0.  12.63 0 20 15 0 0 0 0 0 0 0 0.  12.64 0 15 55 50 0 15 60 30 30 30 30 30 30 30 30 30 30 30 30 30	10	10	20	047	0	15	70	23,33	
11.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1,10	7	45	20	0	0	0	11.66	
11.63 0 20 15 0 0 0 5 20 22.  12.63 15 55 50 0 0 0 0 2 2.  12.64 0 0 30 30 30 30 30 30 30 30 30 30 30 30	.11	0	0	2	0	0	0	0.83	
12.63 0 5 10 0 0 0 2. 12.64 0 35 30 35 30. 12.64 0 30 40 20 25 35 30. 13.64 0 30 20 0 30 35 33. 14.0 0 20 20 25 25 35 35 33. 15.4 0 25 25 15 20 25 25 25 20. 15.4 10 35 25 15 20 20 25 25 20. 15.4 0 20 20 10 20 0 0 0 0 0 0 0 0 0 0 0 0 0	1,11	0	20	15	0	0	r,	99.9	
12.63 15 55 50 0 30 35 30 30 35 30 30 35 30 30 30 30 30 30 30 30 30 30 30 30 30	.12	0	20	10	0	0	0	2,50	
1.64 0 45 30 15 60 30 30 30 15 61 15 60 30 30 30 30 30 30 30 30 30 30 30 30 30	1,12	15	55	50	0	30	35	30.83	
1.64 35 80 40 25 15 5 33.3 2.64 0 30 20 0 15 15 15 13.3 2.64 10 50 40 20 25 25 35 33.3 3.64 10 25 25 5 20 25 25 20.0 3.64 10 35 25 5 0 25 20.0 3.64 0 0 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	ri.	0	145	30	15	9	30	30,00	
2.64 0 30 20 0 15 15 15.3 2.64 10 20 20 25 25 55 33.3 3.64 0 25 30 25 15 20 25 35.3 3.64 10 35 25 15 20 25 20.0 3.64 10 35 5 0 10 20 20 20 20 20.8 3.64 0 20 0 10 20 20 0 8.3 3.64 0 20 0 10 20 20 0 8.3 3.64 0 20 0 10 20 20 20 20 20 20 20 20 20 8.3 3.64 0 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.1	35	80	047	.25	15	20	3	
2.64 10 50 40 20 25 55 33.3 3.64 0 25 5 20 25 35 35 35 35 35 35.3 3.64 10 35 25 15 20 25 20.0 4.64 10 35 5 0 10 20.8 4.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	3	0	30	20	0	1.5	15	3	
3.64 0 25 20 25 20 25 20 25 20 25 20 25 20.0 25 20.0 25 20.0 25 20.0 25 20.0 25 20.0 25 20.0 25 20.0 20 20 20 20 20 20 20 20 20 20 20 20 20	1.20	10	50	047	20	25	55	3	
3.64 5 30 25 15 20 25 20.0 4.64 10 35 5 0 35 40 20.8 4.64 0 0 0 0 0 0 8.3 5.64 0 0 0 0 0 0 0 8.3 of Growth 5.00 29.50 17.0 6.50 18.25 14.75		0	252	20	20	25	35	3	
4.64 10 35 5 0 35 40 20.8 4.64 0 20 0 0 0 0 0 0 8.3 5.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	-	20	30	25	15	20	25	0	
4.64 0 20 0 10 20 0 8. 5.64 0 0 29.50 17.0 6.50 18.25 14.75 of Growth Regulators 29.5 18.25 17.0 14.75 6.5 5.0	.4.	10	35	ıν	0	35	97	8	
of Growth 5.00 29.50 17.0 6.50 18.25 14.75 0f Growth Regulators 29.5 18.25 17.0 14.75 6.5 5.0	1.4°	0	20	0	10	30	0	8,33	
of Growth 5.00 29.50 17.0 6.50 18.25 lator of Growth Regulators 29.5 18.25 17.0 14.75 6.5 5.0	5.	0	0	0	0	0	0	0	ı
of Growth Regulators 29.5 18.25 17.0 14.75 6.5 5	of	5.	5	17.0	6,50	18,25	14.75		1
	of			18,25		6.5 5			
		,							

Mean of 33.33 30.83 30.0 23.33 20.83 20.0 18.33 15.83 13.33 12.5 11.66 8.33 6.66 2.5 0.83 Planting Dates

0

Means underlined by the same line do not differ significantly at the 5% level. N.B.

gave the highest rooting percentage (16.5%) in 90 days which was significantly different from the rooting percentages (11.5 to 4.25%) obtained with the rest of the growth regulators. The control produced the lowest (2.25%) percentage of rooted cuttings.

## Quality of Rooting:

As shown in tables 11 to 15 quality of rooting was more affected by planting dates than by growth regulators. Plantings on January 21 and February 21, 1964 produced significantly higher percentages of well-rooted cuttings than the rest of the planting dates.

Cuttings treated with growth regulators produced good quality roots faster than control cuttings. However after 90 days there were no differences among them as the non treated cuttings had the same quality roots as those treated.

IBA at 3000 ppm, however, was found to differ significantly from the control in inducing better root quality.

## Mortality:

As is evident from tables 16 to 20 survival of the cuttings was affected by planting dates. High mortality was observed during the first 45 days after planting but it decreased as time advanced so that negligible numbers of cuttings died during the period 75 to 90 days after planting.

Percentage of Softwood Olive Cuttings, 30 Days after Planting. Effect of Planting Dates and Growth Regulators on Rooting Table 6.

21.7.63 6.8.63 6.9.63 6.9.63 6.10.63 6.11.63 6.11.63 6.12.63 6.12.63	30 30	1BA 5000ppm	Withtant			Planting Date
00000000000000000000000000000000000000	001/0		Solution	Nutrient Flus IBA 3000ppm	NAA 4000ppm	
00000000000000000000000000000000000000	01/0	0	0	0	0	0
000000000000000000000000000000000000000	NO	0	0	0	0	0
000000000000000000000000000000000000000	C	0	0	0	0	0,83
004444	)	0	0	0	0	
004444	0	0	0	0	0	0
000000000000000000000000000000000000000	0	0	0	0	0	0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0	0	0	0	0
00000000000000000000000000000000000000	0	0	0	0	0	0
2000 2000 2000 2000 2000 2000 2000 200	0	0	0	0	0	0
4997	0	0	0	0	0	0
4.40	0	0	0	0	0	0
10	0	0	0	0	0	0
0	0	0	0	0	0	0
1	0	0	0	0	0	0
2	0	0	0	0	0	0
6.3.64	0	0	0	0	0	0
3	0	0	0	0	0	0
7.	0	0	0	0	0	0
49.	0	0	0	0	0	0
6.5.64	0	0	0	0	0	0
Mean of Growth 0	0.25	0	0	0	0	
Regulator						

Growth Regulators : Non Significant

Planting Dates : Non Significant

Percentage of Softwood Olive Cuttings, 45 Days after Planting. Effect of Planting Dates and Growth Regulators on Rooting Table 7.

Planting			Ú	Growth Regulators	Lators		Mean of	00+00
Dates	Control	IBA 3000ppm	IBA 5000ppm	Nutrient Solution	Nutrient Plus IBA 3000ppm	NAA 4000ppm		2
10	0	0	0	0	0	0	0	1
6.8.63		0	0	0	0	0	0	
8	0	2	0	0	10	0	2.50	
	0	0	0	0	0	0	0	
		0	0	0	0	0	0 (	
.10		0	0	0	0	0	0 0	
.10	0	0	0	0	0	0	0 (	
11.		0	0	0	0	0	0	
11.		0	0	0	0	0	0 (	
122	0	0	0	0	0	0	0 (	
21,12,63	0	0	0	0	0	0	0 (	
L	0	0	0	0	0	0	0	
rį.	0	25	25	20	0	5	10,00	
3	0	0	0	0	0	0	0	
N	0	10	20	0	0	0	2.50	
3	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	
+	0	r	0	0	0	0	0.83	
4.	0	0	0	0	0	0	0	
6.5.64	0	0	0	0	0	0	0	
Mean of Growth Regulator	wth o	2,25	1.50	0.25	0.50	0.25		
	Mean of	Growth Regulators	ulators	: Non Sign	Non Significant			

Means underlined by the same line do not differ significantly at the 5% level. N.B.

10.0

Mean of Planting Dates

Percentage of Softwood Olive Cuttings, 60 Days after Planting. Effect of Planting Dates and Growth Regulators on Rooting Table 8.

Dates Control IBA IBA Mutrient Mutrient Plus MAA 3000pm 3000ppm 5000ppm 5000pp	63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		Withtentent.	1100		
7.63 8.63 8.63 9.63 10.63 10.63 11.63 11.63 12.63 12.63 13.64 14.64 15.64 16.64 16.64 17.64 18.65 18.65	633 633 633 633 633 633 633 633 633 633		Solution	Nutrient Plus IBA 3000ppm	NAA 4000ppm	Or The Control of the
8.63 8.63 9.63 10.63 10.63 11.63 12.63 12.64 13.64 13.64 14.64 15.64 15.64 16.5 16.4 16	00000000000000000000000000000000000000	0	0	0	0	0
8.63 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00000000000000000000000000000000000000	0	0	0	0	0
10.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00000000000000000000000000000000000000	0	0	2	0	1.66
10.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00000000000000000000000000000000000000	0	0	0	0	0
10.63 0 10 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00000000000000000000000000000000000000	0	0	0	0	0
10.63 0 10 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	111063	20	0	70	0	5.83
11.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	11.63	7/	0	0	0	
11.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	12.63	0	0	0	0	0
12.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	12.63	0	0	0	0	0
12.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	12.63	0	0	0	0	0
5.1.64 0 15 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0	0	0	0	0
1.64 0 65 30 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.64 0 1	10	. 0	0	т,	
5.2.64 0 25 20 10 10 10 3.5.64 0 25 20 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.64	30	15	0	20	19.16
2.2.64 0 25 20 10 10 10 3.5.64 0 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2.64 0	0	0	0	N	
5.3.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2 64 0 2	20	10	10	15	
3.64 0 20 0 5 10 5.4.64 5 15 5 0 20 4.64 0 0 0 0 0 0 5.5.64 0 0 0 0 0 0 of Growth 0.25 8.50 4.50 1.50 2.50	3.64	0	0	0	10	-
5.4.64 5 15 5 0 20 4.4.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	3.64	0	77	TO	15	8,33
of Growth 0.25 8.50 \$\text{\$\psi_0\$} 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4.64	r	0	20	30	
of Growth 0.25 8.50 4.50 1.50 2.50	0 49.4	0	0	0	0	0
rowth 0.25 8.50 4.50 1.50 2.50	5	0	0	0	0	0
	of Growth 0.25 8.	4.50	1.50	2,50	4.25	

Means underlined by the same line do not differ significantly at the 5% level. N.B.

1,66

2.5

2.0

5.83

Mean of Planting Dates

Percentage of Softwood Olive Cuttings, 75 Days after Planting. Effect of Planting Dates and Growth Regulators on Rooting Table 9.

.7.63			The second secon	D			The state of the s	
.7.6	Control	IBA 3000ppm	IBA 5000ppm	Nutrient Solution	Nutrient Plus IBA 3000ppm	us NAA 4000ppm	bm Francing	22
		0	0	0	0	0	0	
9		0	0	0	0	0	0	
8.6		v	0	0	15	2	4.16	
6.9.63		10	0	0	10	0		
9.6		0	0	0	0	0	0	
10		10	20	0	7	0	5.83	
.10.6		10	2	0	0	0	2.50	
.11.63		0	0	0	0	0	0	
.11.63		10	10	0	0	Ŋ	4.16	
.12.6		0	0	0	0	0	0	
12.63		20	15	0	0	0		
6.1.64		30	10	2	50	20	19,16	
17.64		65	30	15	0	N		
6.2.64		10	15	0	r	7		
C		04	20	15	20	25	- 0	
6.3.64		20	0	0	10	20	8,33	
21.3.64 5		20	10	15	20	20		
4.9		15	150	0	20	30		
4		'n	0	0	15	0		
6.5.64 0		0	0	0	0	0		
Mean of Growth 1.8	.25	13.00	00.7	2.50	8.00	6.75		
Mean of	Growt	Growth Regulator	rs : 13	13.0 8.0	7.0 6.75	2.5 1.25		

Means underlined by the same line do not differ signifidantly at the 5% level.

20.0 19.16 15.0 12.5 8.33 5.83 4.16 3.33 2.5

Mean of Planting Dates

Percentage of Softwood Olive Cuttings, 90 Days after Planting. Effect of Planting Dates and Growth Regulators on Rooting Table 10.

Planting			G.	Growth Regulators	tors		
Dates	Control	IBA 3000ppm	IBA 5000ppm	Nutrient Solution	Nutrient Plus IBA 3000ppm	NAA 4000ppm	Planting Date
.7.6	0	0	0	5	0	0	0.83
8.6	0	0	0	0	0	0	0
21.8.63	0	15	0	0	20	20	9.16
6.9.6	0	0	0	0	0	0	. 0
6	0	0	0	0	0	0	0
10.6	0	10	20	0	70	0	5.83
21.10.63	0	35	10	0	0	0	7.50
,11,6	0	0	0	0	0	0	0
.11.6	0	10	10	0	0	2	4.16
.12.6	0	0	0	0	0	0	0
.12.6	15	25	35	0	20	20	
.1.64	0	30	10	20	50	20	19.16
21.1.64	20	25	35	252	50	2	
2.	0	10	15	0	15	2	
	0	547	047	15	25	50	-
	0	25	0	15	25	35	
21,3,64	70	20	10	15	20	20	
49.4.9	7	20	7	0	25	30	- 40
21.4.64	0	10	0	2	20	0	
6.5.64	0	0	0	0	0	0	_ ,
ean of Growth	ch 2,25	16.50	9.50	4.25	11.50	10,50	
The state of the s	A THE OWN PARTY AND ADDRESS OF THE PERSON NAMED IN	The real Property lies and the least lies and the l		The state of the last of the l	the design of the second of th	The state of the s	The state of the s

9.16 7.5 5.83 4.16 0.83 0 N.B. Means underlined by the same line do not differ significantly at the 5% level. 29,16 27,5 19,16 16,66 15,0 14,16 Mean of Planting Dates

4.25

10.5

Mean of Growth Regulators

Effect of Planting Dates and Growth Regulators on Quality of Rooting of Softwood Olive Cuttings, 30 Days after Planting. Table 11.

Planting	30					Growth Be	Regulators			Mean of	of
Dares	Control WR-PR		IBA 3000ppm WR-PR	IBA 5000ppm WR-PR	ppm R	Nutrient Solution WR-PR	Nutr IBA WB-	tent Plus 3000ppm PR	NAA 4000ppm WR-PR		PR
.7.6	o	0	0	0	0					0	0
6.8.63	0	0		0	0	0	0		0 0	0	0
8.6		0	70		0			6		0	0.83
9.6		0			0			0		0	0
9.6.		0			0					0	0
		0			0			)		0	0
,10.6		0			0			-		0	0
,11.6		0			0			0		0	0
.11.		0			0			0		0	0
		0			0			0		0	0
21,12,63		0	0		0					0	0
		0			0					0	0
21.1.64		0						•		0	0
9.		0	0		0					0	0
21.2.64		0			0			_		0	0
.3		0	0		0			_		0	0
21.3.64		0	0		0					0	0
49.4.9		0			0					0	0
7.		0	0		0			0		0	0
6.5.64		0			0		0		0	0	0
Mean of		0	0.25		0			0			
Growth											
Regulator											

Mean of Growth Regulators : Non Significant Mean of Planting Dates : Non Significant

WR : Well-rooted

PR : Poorly-rooted

Effect of Planting Dates and Growth Regulators on Quality of Rooting of Softwood Olive Cuttings, 45 Days after Planting. Table 12.

Control   IBA   Nutrient   Nutr	Planting Potos						G	Growth E	Regulators	ators				Mean	
8.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	n DD DD DD DD DD DD DD DD DD DD DD DD DD	Con	trol - PR	JOE WANG	A NOppm	1	Oppm PR	Nutri Solut	lent tion PR	Nutr IBA WR	1 54		PR PR	- Flant	ing Date
8.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.7.6	0	0	0	0		0	0	0	0	0	0	0	0	0
8.63 0 0 5 0 0 0 0 0 0 0 0 1.66  10.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	.8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	
9.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.8.6	0	0	ın	0	0	0	0	0	70	7	0	0	1.66	
10.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	9.6	0	0	0	0	0	0	0	0	0	0	0	0	0	
10.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.9.6	0	0	0	0	0	0	0	0	0	0	0	0	0	
10.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	.10.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1,10,6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	,11.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1,11,6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	.12.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	,12.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.64 0 0 20 5 15 10 5 0 0 0 0 7.50 2 2.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.64 0 0 0 0 0 0 0 0 0 0 0 0 0 4.64 0 0 0 0 0 0 0 0 0 0 0 0 5.64 0 0 0 0 0 0 0 0 0 0 0 0 5.64 0 0 0 0 0 0 0 0 0 0 0 0 5.64 0 0 0 0 0 0 0 0 0 0 0 0 5.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.64	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1:	0	0	20	2		10	N	0	0	0	2	0	7.50	
2.64 0 0 0 10 0 5 0 0 0 0 0 0 0 0 0 0 0 3.3.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	C.	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	CV.	0	0	0	10	0	2	0	0	0	0	0	0	0	2.50
3.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.64 0 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	7.	0	0	0	2	0	0	0	0	0	0	0	0	0	0.83
of Growtho 0 1.25 1.0 0.75 0.75 0.25 0 0.25 0.25 0.25 1.0 0.25	1.4.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
of Growtho 0 1.25 1.0 0.75 0.75 0.25 0 0.25 0.25 0.25 lator	7,	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	of	wtho	0					0.25	0	0.25	0.25	0.25	0		

Mean of Growth Regulators : Non Significant Mean of Planting Dates : (WR) 7.5 1.6

(WR) 7.5 1.66 (PR) 2.5 0.83

> WR : Well-rooted PR : Poorly-rooted

Means underlined by the same line do not differ significantly at the 5% level. N.B.

Effect of Planting Dates and Growth Regulators on Quality of Rooting of Softwood Olive Cuttings, 60 Days after Planting. Table 13.

Planting						Gro	Growth B	Regulators	tors					of.	4
Dates	Control	1	IBA				Nutr	Nutrient	Nutr1	rient Plus		MAA		Planting D	Date
	WB - I	댎	3000ppm WR - PR	E.G.	5000J	PR PR	Solu WR -	Solution WR - PR	IBA	3000ppm - PR	7	WR -	PH	WR - PR	- 1
9.	0	0	0	0	0	0	0	0	0	0		0	0	0	
8.6	0	0			0	0	0	0	0	0	_	0	0	0	
21.8.63			v	0	0	0	0	0	0	70	•	0	0	0.83 0.8	83
9.6					0	0	0	0	0	0		0	0	0	
9.6		0			0	0	0	0	0	0		0	0	0	
6,10.6		0			15	5	0	0	N	0	_	0	0		83
.10.6		0			, E	0	0	0	0	0		0	0	• 0 99•	33
6,11,63		0	0		0	0	0	0	0	0		0	0	0	
.11.6		0	0		0	0	0	0	0	0		0	0	0	
6.12.63		0	0		0	0	0	0	0	0		0	0	0	
12.6		0	0		0	0	0	0	0	0	_	0	0	0	
6.1.64						10	0	0	0	0		20	0	1,66 3,3	33
21.1.64			09		30	0	15	0	0	0	- 1	N	0	33 0.	8
22.		0	0		0	0	0	ó	0	0		0	20	-	26
	0	0	10	15	0	20	N	7	0	10	-	5	0	3,33 10,	Ŏ,
.3					0	0	0	0	0	0		0	0	ď	99
3					0	0	0	N	0	10		0	7	1,66 6,6	99
49.4.9			10		r	0	0	0	7	N	20		0	.16 3.	33
47.		0	0		0	0	0	0	0	0		0	0	0	
6.5.64		0	0		0	0	0	0	0	0		0	0	0	- 1
Mean of Grow Regulator	Growtho.25 C	5	.75	2.75	2.75	1.75	1.0	0.5	J.0	1.5	۲.	75 2.	2		
	-		-												

0.83 0.25 1.66 1.0 5.0 Non Significant 2.25 9.16 (WE) PB) Mean of Growth Regulators

18.33 (WB) (PB) Mean of Planting Dates

0,83

Poorly-rooted Well-rooted WE Means underlined by the same line do not differ significantly at the 5% level. N.B.

Quality of Effect of Planting Dates and Growth Regulators on Quality of Rooting of Softwood Olive Cuttings, 75 Days after Planting.

Planting					Gro	Growth Re	Regulators	tors			Mean	Jo.
Date	Control WR - PR		1BA 3000ppm WR - PR	IBA 5000] WR -	ppm PR	Nutrient Solution WR - PR	lent Sion	Nutr IBA WR	Nutrient Plus IBA 3000ppm WR - PR	NAA 4000pm WR - PR	PISNT	ing Date - PR
21.7.63	0 0	0	0	0	0	0	0	0	0	0	0	0
.8.6	0	0	0	0	0	0	0	0	0		0	0
21,8,63		r	0	0	0	0	0	75	0	5	4.16	0
9.6.9		0	0	0	0	0	0	0	0		0	0
21.9.63		0	0	0	0	0	0	0	0	0	0	0
6,10,63		10	0	15	7	0	0	v	0	0	70	
.10.6		7	5	ın	0	0	0	0	0		1,66	0.83
6.11.6		0	0	0	0	0	0	0	0		0	
.11.6	0	10	0	10	0	0	0	0	0	5	4,16	0
		0	0	0	0	0	0	0	0	0	0	0
21,12,63		10	10	10	r	0	0	0	0			- 0
6.1.64		25	v	10	0	r	0	9	10	20 0		
21.1.64	0	9	'n	30	0	17	0	0	0	5	18,33	0,83
6.2.64		10	0	15	0	0	0	r	0	0		
21.2.64		35	20	15	20	15	0	13	5		9.	3.33
6.3.64		10	10	0	0	0	0	0	10	10 10	3	
21,3,64		20	0	10	0	15	0	20	0	20 0	15,00	0
		10	N	N	0	0	0	15	2	20 10	2	3
7.		0	M	0	0	0	0	10	N	0	9	1,66
6.5.64		0	0	0	0	0	0	0	0	0	0	0
Mean of Growthl Regulator	sh1,25 0	10.5	2.5	6.25	0.75	2.5	0	6.25	1.75	5.25 1.	2	
							1					

18,33 16,66 15,0 9,25 5,83 5,0 4,16 3,33 1,66 0 2.5 1.75 1.5 0.75 0 (ME) PR) (ME) Mean of Growth Regulators Mean of Planting Dates

0.83 1.66 (PB)

WR : Well-rooted PR : Poorly-rooted Means underlined by the same line do not differ significantly at the 5% level. N.B.

Effect of Planting Dates and Growth Regulators on Quality of Rooting of Softwood Olive Cuttings, 90 Days after Planting, Table 15.

Control   IBA   IBA   Nutrient   Nutrient Flus   NAA	63					Б	Growth	Regul	Regulators				
7.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Dates	ntr		1BA 3000ppm VR - PR	1		Nutri Solut	lent clon PR	P-1	1 24	1	A DOPPER	- Flanting Date
8.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.7.6			0	0	0	0	v	0	0	0	0	0 0.83
8.63 0 0 10 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6.8.6			0	0	0	0	10	0	0	0	0	0
9.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.8.6		Н		0	0	0	0	15	10	75	3	99
9.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	9.6				0	0	0	0	0	0	0	0	
10.63 0 0 10 0 15 5 0 0 0 0 0 0 0 0 0 0 0 0 0	1.9.6	1021			0	0	0	0	0	0	0	0	0
10.63 0 0 35 0 10 0 0 0 0 0 0 0 0 0 0 11.63 0 0 10.00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6,10,6		П		15	2	0	0	20	0	0	0	
11.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1,10,6	20	m		10	0	0	0	0	0	0	0	7.50 0
11.63 0 0 10 0 10 0 0 0 0 0 0 0 0 0 0 0 0 0	.11.6				0	0	0	0	0	0	0	0	0
12.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1,11,6	224			10	0	0	0	0	0	3	0	4.16 0
12.63 15 0 25 0 35 0 0 0 15 5 20 1.64 0 0 25 5 10 0 5 0 40 10 0 25 0 5 0 40 10 20 2.64 0 0 10 75 0 35 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 1	,12,6		-		0	0	0	0	0	0	0	0	0
1.64 0 0 25 5 10 0 5 0 40 10 20  2.64 10 10 75 0 35 0 25 0 5 0  2.64 0 0 10 0 15 0 0 15 0 25  3.64 0 0 20 5 0 10 0 15 0 25 0 45  3.64 5 0 20 5 0 10 0 15 0 25 0 25  4.64 5 0 15 5 5 0 0 0 15 0 20  0.6 Growth Regulators (WR): 15.25 9.75 9.5 9.75 1.75	1,12,6	2			35	0	0	0	15	70	20	0	.33 0.8
1.64 10 10 75 0 35 0 25 0 5 0 6 0 15 0 15	r.				10	0	2	0	45	10	20	0	.66 2.5
2.64 0 0 10 0 15 0 0 0 15 0 0 15 0 0 15 0 0 15 0 25 0 45 0 15 0 25 0 45 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 25 0 15 0 1	1.1.	Н			35	0	25	0	N	0	5	0	
2.64 0 0 45 0 40 0 15 0 25 0 45 3.564 0 0 20 25 0 45 3.564 5 0 20 5 0 0 15 0 25 0 35 35 44 5 0 20 0 10 0 15 0 20 0 25 0 35 35 44 5 0 15 5 5 0 0 0 15 10 25 35 44 0 0 5 5 5 0 0 0 5 15 5 0 0 0 0 5 15 5 0 0 0 0	C.				7	0	0		75	0	0	2	.66 0.8
3.64 0 0 20 5 0 0 15 0 25 0 35 3.64 5 0 20 0 10 0 15 0 20 0 20 4.64 5 0 15 5 5 0 0 15 10 25 5.64 0 0 5 15 25 1.25 9.25 0.25 3.75 0.5 9.25 3.75 1.75 Mean of Growth Regulators (WB): 15.25 9.75 9.5 9.5 3.75 1.75	1.2.	0			2	0	15	0	22	0	5	N	.33 0.8
3.64 5 0 20 0 10 0 15 0 20 0 20 4.64 5 0 15 5 5 0 0 15 10 25 5.64 0 0 5 15 5 0 0 0 5 15 5 0 of Growth Regulators (WB): 15.25 9.75 9.5 9.5 3.75 1.75	3.	0			0	0	13	0	25	0	35	0	.83 0.8
4.64 5 0 15 5 5 0 0 0 15 10 25 4.64 0 0 5 5 5 0 0 0 25 5.64 0 0 0 0 0 5 15 5 0 0 5.64 0 0 0 0 0 0 0 0 0 0 0 15.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	3				10	0	15	0	20	0	20	0	
4.64 0 0 5 5 0 0 0 5 5 0 0 0 5 15 5 0 0 0 15 5 0 0 0 0	7.				20	0	0	0	H	TO	25	N	10.83 3.33
of Growth 75 0.5 15.25 1.25 9.25 0.25 3.75 0.5 9.75 1.75 9.5 1.75 9.5 1.75 Mean of Growth Regulators (WR): 15.25 9.75 9.5 9.5 3.75 1.75	1.4.				0	0	0	5	15	N	0	0	.33 2.5
of Growth, 75 0.5 15.25 1.25 9.25 0.25 3.75 0.5 9.75 1.75 9.5 1.75 Mean of Growth Regulators (WR): 15.25 9.75 9.5 9.25 3.75 1.75	.5.6				0	0	0	0	0	0	0	0	0
of Growth Regulators (WR): 15.25 9.75 9.5 9.25 3.75 1.	of		.5 1	.25 1.	6	0	3	0.5	9.75	1.75	9.5	1.0	
	Mean of			lators	(WE):	15,25	9.7	9.	9.2	3.75	1.75		

Mean of Planting Dates(WR): 28,33 25,83 18,33 16,66 15,83 15,0 10,83 7,5 6,66 5,0 4,16 3,33 0 9.25 3.75 1.75 (PR): Non Significant

(PR): Non Significant

WR : Well-rooted PR : Poorly-rooted N.B. Means underlined by the same line do not differ significantly at the 5% level.

The highest mortality percentage was recorded for the cuttings planted on July 21 (59.16%) and August 6 (45.0%) and the least (Maximum of 8.33%) for the winter and spring plantings (January 6 to May 6, excepting, March 6). It was observed that cuttings started dying earlier when planted in summer (July and August) and winter (December) as compared with cuttings planted in spring (February to April).

The growth regulator treatments employed in this study did not show significant effects on the percentage of mortality. The final mortality percentage recorded 90 days after planting was appreciably less (13.75%) with the control cuttings, cuttings treated with IBA at 3000 ppm (11.25%) or cuttings treated with IBA at 3000 ppm plus nutrients (12.0%) as compared with data recorded for the cuttings treated with IBA at 5000 ppm (17.75%), nutrients solution (17.25%) or NAA (19.5%).

Table 16. E

Effect of Planting Dates and Growth Regulators on Percentage Dead Softwood Olive Cuttings, 30 Days after Planting.

Planting.	•		0	Growth Regul	Regulators		
Dates	Control	IBA 3000ppm	IBA 5000ppm	Nutrient	Nutrient Plus IBA 3000ppm	NAA 4000ppm	Planting Date
1 .	30	25	45	30	5	55	31.66
6.8.6	r	0	0	0	ıv	0	
8.6	0	7	3	0	0	0	1.66
9.6.9	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
6.10.63	0	0	0	0	0	0	0
.10.6	0	0	0	0	0	Ø	0
6.11.6	0	0	0	0	0	0	0
11:	0	0	0	0	0	0	0
6,12,63	0	0	0	0	0	0	0
21,12,63	0	0	0	0	0	0	0
6.1.64	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
49.4.9	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
1 of	th 1.75	1.50	2,50	1.50	05.0	2.75	
REGULATOIT.							

Growth Regulators : Non Significant

Means underlined by the same line do not differ significantly at the 5% level. N.B.

Mean of Planting Dates: 31.66 1.66

Effect of Planting Dates and Growth Regulators on Percentage of Dead Softwood Olive Cuttings, 45 Days after Planting. Table 17.

21.7.63 30 45 6.8.63 45 6.9.63 0 21.9.63 0 6.10.63 0 6.11.63 0	the same of the sa					100
20000000000000000000000000000000000000	JBA 3000ppm	IBA 5000ppm	Nutrient Solution	Nutrient Flus IBA 3000ppm	NAA 4000ppm	Francing Date
\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	25	45	30	5	55	31.66
00000000000000000000000000000000000000	30	30	10	у.	7	20,83
200000 200000	2	10	0	0	0	2.50
11000 633 633 633 633	0	0	0	0	0	0
5000	0	0	0	0	0	0
10.63	0	0	0	0	0	0
.11.63	0	0	0	0	0	0
11 63	0	0	0	0	0	0
O * TT *	0	0	0	0	0	0
.12.63	55	15	047	35	20	35.83
.12.63	0	N	2	10	1,5	99*9
.1.64	0	0	0	0	0	0
ri.	0	0	2	2	N	3.33
	0	0	0	0	0	0
2.64	0	0	0	0	0	0
	0	0	0	0	0	0
21.3.64 0	0	0	0	0	0	0
19.4.	0	10	N	0	0	2.50
21.4.64 5	70	10	N	0	70	5.00
6.5.64	0	0	0	0	0	0
Mean of Growth 5.50	0.9	6.25	5.0	3.0	6.75	

20.83 6.66 5.0 3.33 31.66 35.83 Mean of Planting Dates :

Non Significent

Growth Regulators

Means underlined by the same line do not differ significantly at the 5% level. N.B.

Effect of Planting Dates and Growth Regulators on Percentage of Dead Softwood Ollve Cuttings, 60 Days after Planting. Table 18.

1000					Ω	בוב	an or
	Control	1BA 3000ppm	IBA 5000ppm	Nutrient Solution	Nutrient Plus IBA 3000ppm	NAA 4000ppm	Planting Date
21.7.63	50	20	80	45	047	70	59.16
0,	去	30	30	10	70	20	20.83
21.8.63	0 (	N	10	0	0	0	2.50
0 4	0 0	0 (	rV (	ž	0	10	3.33
	00	00	00	00	0 0	0 (	0 (
1	) U	0 0	0 0	0 0	0	0	0
12	0	o c	0 0	00	00	00	0,83
H	0	0	0	00	00	00	000
17	20	55	15	040	35	50	35.83
21.12.03	2,5	0 (	<i>ν</i> ,	7	10	15	99.9
: .	21	0 (	010	H.	0	0	5.83
	nc	o c	00	v	v (	rU (	3.33
	0	00	00	0 0	ΟV	00	25
3	0	0	0	90	30	000	0 1 1 1
21.3.64	0	0	0	To	10	0 0	000
4	0	0	10	K	'n	0 0	3 6
21.4.64	N	5	10	ľ	10	) Y	100
6.5.64	0	0	0	0	0	10	0
Mean of Growth Regulator	7.25	8.25	8.75	7.75	00°9	8.00	
Growth Re	Regulators	: Non	. Significant	nt			
Mean of Planting	ting Dates	. 59.16	16 35.83	20.83 6.66	2 2 2 2	11 76 2 22	00 0 00 00 00

Means underlined by the same line do not differ significantly at the 5% level. N.B.

Effect of Planting Dates and Growth Regulators on Percentage of Dead Softwood Olive Cuttings, 75 Days after Planting. Table 19.

Control IBA IBA Mutrient Nutrient Flus NAA 4000ppm 45 3000ppm 50lution IBA 3000ppm 4000ppm 60lution IBA 3000ppm 4000ppm 60lpm	Flanting Dates			Gre	Growth Regulators	core			
\$3 \$50 \$70 \$80 \$\frac{45}{55}\$\$ \$50 \$50 \$50 \$50 \$50 \$50 \$50 \$50 \$50 \$50	200	Control	1BA 3000ppm	1BA 5000ppm	Nutrient Solution	Nutrient Plus IBA 3000ppm	NAA 4000ppm	Planting 1	Dat
45 30 45 12.75 8.75 15.75	2.6	50	70	80	45	047	20	1	
63	8.6	45	30	30	10	2	70	8	
63 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0.0	2	N	45	0	15	0	9	
63 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	9.0	0 (	0 (	W.	N	0	10	4	
63 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	7.0	0	0	0	0	0	0		
63 10 25 15 25 25 10 25 25 10 25 25 10 25 25 25 25 25 25 25 25 25 25 25 25 25	10	01	0 (	10	0	0	45		
63 40 15 25 25 25 25 20	70	2	01	0	0	0	0		
63 20 15 25 40 35 50 35 50 35 60 35	1	01-	5	15	25	TO	55		
63 20 55 15 40 35 50 15 10 15 10 10 15 10 10 15 10 10 10 10 10 10 10 10 10 10 10 10 10	11.	9	J.	25	50.	200	52		
10 5 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 15 15 15 15 15 15 15 15 15 15 15 15	12.	20	22	15	040	35	20		
10 0 10 15 0 0 5  14 5 0 0 0 15 5 5  15 0 0 0 0 5  16 0 0 15 15  17 0 0 15 0 0  18 10 0 0 0  19 0 0 0 0  10 0 0 0	12.	10	rU	10	15	70	15		
14     5     0     0     5     3       14     0     0     0     0     0     0       14     15     0     15     0     0     5       14     10     0     15     10     0     5       14     0     0     10     5     0     3       14     0     0     0     0     3       15     0     0     0     5     0       10     0     0     0     0     0       11,50     9,50     14,75     12,75     8,75     15,75	ř	10	0	10	15	0	0	- 4	
14 15 0 0 0 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.1.	N	0	0	N	20	N		
15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6.2.	0	0	0	N	0	0		
15 0 15 0 0 5. 14 10 0 15 10 0 0 7. 14 5 5 10 5 0 0 0 3. 14 5 5 10 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.2.	0	0	0	15	15	0	- 4	
1.3.64 10 0 15 10 10 0 7.8 6.4.64 0 0 10 0 7.8 6.4.64 0 0 10 0 0 3.8 5.5.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6.3.	15	0		0	0	0		
14 5 5 10 5 0 3. 14 5 0 0 0 0 5 5 0 5. 14 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.3	10	0		10	OI	0	-	
4 5 5 10 5 0 5 5 5 6 0 0 0 5 0 5 0 0 0 0 0 0 0	4.9	0	0		N	ī.	0		
owth 11.50 9.50 14.75 12.75 8.75 15.75	HV	N	M		N	0 (	N		
owth 11.50 9.50 14.75 12.75 8.75 15	0.2.04	0	0	0	0	0	0	0	
	1 of Growth	11.50	n	14.75	12.75	8.75	15.75		

59.16 35.83 20.83 20.0 11.66 10.83 9.16 7.5 5.83 5.0 3.33 0.83 0 Mean of Planting Dates

: Non Significant

Growth Regulators

Means underlined by the same line do not differ significantly at the 5% level. N.B.

Effect of Planting Dates and Growth Regulators on Percentage of Dead Softwood Olive Cuttings, 90 Days after Planting. Table 20.

Planting	ė.		Gre	Growth Regulators	core		Mean of
	Control	IBA 3000ppm	IBA 5000ppm	Nutrient Solution	Nutrient Flus IBA 3000ppm	NAA 4000ppm	Stranger
.7.6	50		80	45	047	202	59.16
0 0	9 4	W A	000 H	30	5 r	to	
9	0	10	jw	) V	10	10	
9.63	30	rU (	N	00	10	202	
0.0I.	o v	o v	010	D V	0 0	tr	
11.	197	ربر	75	25,	10	55	20.00
.11.6	25	μ, χ,	201	50	50 C	10 m	
12.6	02	Un	701	251	201	12	
1.64	01	10	191	15	0	0	
	NC	00	00	N	ν	νC	0°0
2 (1)	000	00	0	22	17.0	0	2 9
3	15	20	25	15	20	2	
3	10	0	15	OT	To	0	
. 47.	0	0	10	N	2	0	•
21.4.64	200	500	000	200	00	νo	2,00
Mean of Growth	Growth 13.75	11,25	17.75	17.25	12,00	19.50	
legulator							

Mean of 59.16 45.0 40.83 35.83 20.0 16.66 11.66 10.83 9.16 8.33 7.50 5.83 5.0 3.33 0.83 0 Non Significant Growth Regulators :

N.B. Means underlined by the same line do not differ significantly at the 5% level.

## DISCUSSION OF RESULTS

Planting dates and growth regulators produced a marked effect on callusing, rooting, rooting quality and survival of the cuttings.

Callusing started earlier in the mid-summer and early spring plantings than in the autumn and winter plantings but rooting was not enhanced. Callusing was retarded but earlier and higher rooting percentages were obtained when the cuttings were planted during the winter and spring months, from December 21, 1963 to April 6, 1964.

Early callusing during the mid-summer period seems to be due to the relatively high temperature (32.63 C - Table 21) occurring during this period. Such high temperatures are known to produce fast and soft callus tissue but not necessarily fast root formation. On the other hand the temperature during the winter and spring months when callusing was retarded was controlled at 20 - 22 C, which seemed to be lower than that required for early callusing. However, the temperature of 20 -22 C was favorable for root formation and appears to be responsible rolable for the earlier and higher rooting percentages obtained during the winter and spring months. Root formation was delayed in mid-summer despite early callusing. This is probably due to the higher temperature prevailing during this period which induced above ground vegetative activity thus interfering with root formation. During winter and spring the cuttings tilings were provided with an optimum soil temperature for

callusing, while the above ground parts were kept from growing; this produced an ideal situation for root formation. Anzilotti (1) also found that olive cuttings will root in 60 to 90 days if the substrate temperature is maintained at 22 to 26 C. Hartmann (13, 14) observed that in general better results were obtained when bottom heat at 23C was used together with high humidity in rooting softwood cuttings of olives.

Early rooting in the winter and spring months also appears to be due to the presence of sufficient reserves of carbohydrates that accumulated in the cuttings during this period of no vegetative activity. It has been established by many investigators (11, 17, 18) that by the onset of the winter period large amounts of carbohydrates accumulate in the shoots and that a high carbohydrate content in cuttings is essential for root formation. According to Garner (11) Starring, Knight and Hatcher all found that a high carbohydrate content of softwood cuttings with low soluble nitrogen favored rooting. Trials of Jacoboni (17) showed that an efficient and rapid method of propagating olives included the use of mist aided by previously ringing the shoots to be used as cuttings. Khan (18) found that olive cuttings taken from normal shoots did not root at all, however, 10% rooting was obtained when cuttings were taken from shoots preconditioned by lifting a two inches wide ring of bark during the summer months. Since olives continue their vegetative growth till late autumn, he suggested that the success

with ringing was probably due to the accumulation of carbohydrates.

Plantings made during winter and spring produced a higher percentage of well-rooted cuttings. This seems to be due to the early rooting of these cuttings which gave the roots a relatively longer time to develop.

Percentage of dead cuttings was high when plantings were made during the summer months. This appears to be due to the high maximum and minimum temperatures (32.63 and 25.17C respectively - Table 21) with a comparatively low relative humidity (71.4%) that prevailed during this time. The above situation induced rapid desiccation and death of the tissues. During the summer months the trees were growing fast and there was fruit on them. Therefore, cuttings taken during this period were low in carbohydrate content which also seems to be responsible for the high mortality of the cuttings.

Untreated cuttings formed roots more readily when planted in the late winter and spring months. This finding is in accordance with the findings of Hartmann (13). He reported more rooting of clives to occur when the cuttings were taken during the fall and winter months as compared to late spring.

Preplanting application of growth regulators to the cuttings enhanced callusing and rooting and increased the rooting percentage of cuttings. The benefits obtained from the use of certain synthetic compounds in rooting cuttings of different plant species have been reported by many investigators

(10, 11, 12, 19, 24, 25, 26). It is believed that-auxin is necessary for root growth (7), and that this material translocates down from the apex of the shoot. Supplying the bases of cuttings with additional auxin or with-some of the synthetic auxin-like compounds such as IBA or NAA will increase the rooting of cuttings. According to Loreti (19), however, callus formation was not affected when cuttings of a number of olive varieties were treated with different synthetic compounds. He, therefore, concluded that varieties responded differently to synthetic growth regulators. The early callusing obtained with treated cuttings of the olive variety "Chatawi", in this experiment indicates that this variety responds to the use of synthetic growth regulators.

of the treatments laters, methylene blue at 25 ppm resulted in the lowest percentage of rooted cuttings. Blattny and Robek (3) reported that the application of 1:1000 solution of methylene blue for 30 minutes stimulated the formation of roots on hop cuttings. The ineffectiveness of this chemical on olive cuttings may be due to the relatively low concentration used or because clives do not respond to this chemical.

22,4-D at 200 ppm also gave poor results as compared to the rest of the growth regulators. The reason for this appears to be the use of too high a concentration (200 ppm) as is indicated by the high mortality percentage (22.6%) of cuttings treated with this compound. Further, 22,4-D might not be

effective in inducing rooting of leafy cuttings of olives.

cuttings treated with IBA at 3000 ppm gave the highest rooting percentage. According to Garner (11), Hooker found IBA useful in stimulating root formation in cuttings of mango which does not root easily without treatment. Hartmann (14) also obtained the highest rooting percentage of softwood clive cuttings by using IBA solutions at 3000 to 7000 ppm.

Treatment with IBA at 3000 ppm resulted in significantly higher rooting percentage than IBA at 3000 ppm plus nutrient solution (Table 10). This finding is contrary to that of Cajlahjan (6) who observed synergism when IAA, IBA or NAA was applied with one of the vitamins which by themselves had no significant effect on root growth. Graham (12), however, found that adenine inhibited rooting of Prunus cerasifera cuttings when used alone and retarded rooting when used with IBA. It, therefore, appears that the nutrient solution and IBA may be antagonistic to one another, or combined do not have any apparent effect on olive cuttings.

## SUMMARY AND CONCLUSIONS

This study was conducted during the year 1963-64 at the American University of Beirut to determine the effect of twenty planting dates and of seven growth regulators on rooting of softwood stem cuttings of the olive variety "Chatawi". The planting dates were 21 st of July, 6th and 21 st of each of the months of August, September, October, November and December 1963, 6th and 21 st of January, February, March and April and the 6th of May 1964. The growth regulators consisted of 22.4-D at 200 ppm, IBA at 3000 ppm and at 5000 ppm, nutrient solution, nutrient solution plus IBA at 3000 ppm, methylene blue at 25 ppm and NAA at 4000 ppm.

Before planting all leaves from the cuttings except the uppermost two were removed and the cuttings treated with the growth regulators using the concentrated-solution-dip method. Cuttings were planted in flats of vermiculite where they remained for a period of 90 days. During the winter and spring months from October 18, 1963 to June 15, 1964 the flats were provided with bottom heat maintained at 20 - 22 C.

The cuttings were examined 30, 45, 60, 75 and 90 days after being placed in the rooting medium for callusing, rooting and survival. Rooted cuttings were classified as well-rooted or poorly-rooted. Only the cuttings that formed at least three roots five centimeters long were classed as well-rooted.

Cuttings planted during mid-summer and early spring

started callusing the earliest but the final percentage of callusing (33.33%) and rooting (29.16%) were the highest for the cuttings planted during the period from December 21, 1963 to February 21, 1964.

The percentage of well-rooted cuttings was significantly higher when the cuttings were taken on January 21 or on February 21, 1964.

The highest mortality was observed for the cuttings planted during the months of July and August.

Whereas all growth regulators except methylene blue produced faster and higher callusing than the control, the highest percentages of callusing and rooting were obtained with IBA at 3000 ppm or IBA at 3000 ppm plus nutrient solution.

Quality of rooting was not appreciably affected by growth regulators and the cuttings treated with growth regulators except IBA at 3000 ppm, did not differ significantly from the untreated cuttings in the percentage of well-rooted cuttings. Treatment of the cuttings with IBA at 3000 ppm, however, significantly increased the percentage of well-rooted cuttings as compared with the control.

The percentage of mortality was the least with the untreated cuttings or cuttings treated with IBA at 3000 ppm alone or in combination with the nutrient solution. The highest mortality was observed for the cuttings treated with NAA at 4000 ppm or IBA at 5000 ppm.

The results of the experiment indicate that the best time for rooting softwood cuttings of the olive variety "Chatawi" in Lebanon is during the winter or spring months. Pre-planting treatment of the cuttings with the root-promoting substance, IBA at 3000ppm, will enhance rooting and will improve the percentage of well-rooted cuttings. A good medium for rooting the cuttings was found to be vermiculite. Bottom heat at about 20 to 24C enhanced rooting. The cuttings should be well watered at regular intervals to prevent drying up of leaves. Under such conditions 75% rooting of cuttings was achieved in a period of 90 days.

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Table 21. Average Monthly Temperature in Degrees C and Rainfall in m.m. at the American Univ. of Beirut from July 1963 to May 1964.

Month		Mean Max. Temp.	Mean Mini. Temp.	Rainfall	Mean Rel. Humidity %
July,	1963	30.94	24.26	0.00	72.2
August,	1963	32.63	25.17	0.00	71.4
September,	1963	30.40	24.09	22.08	67.5
October,	1963	26.83	20.93	94.65	70.6
November,	1963	22.58	17.36	136.80	70.6
December,	1963	18.34	12.58	137.05	66.6
January,	1964	15.16	10.02	96.30	62.2
February,	1964	16.94	10.79	319.90	73.4
March,	1964	19.40.	13.80	91.10	75.7
April,	1964	21.50	15.20	21.10	67.9
May,	1964	23.00	17.00	53.70	72.3

Table 22. Analysis of Variance for Percentage Callusing of Softwood Olive Cuttings, 90 Days after Planting.

Source	D.F.	M.S.	
Planting Dates	19	748.9	xx
Growth Regulators	5	1587.8	xx
Error	95	141.8	

Table 23. Analysis of Variance for Percentage Rooting of Softwood Olive Cuttings, 90 Days after Planting.

Source	D.F.	M.S.
Planting Dates	19	998.7 xx
Growth Regulators	5	2314.5 xx
Error	95	6.4

xx Denotes F values significant at the 1% level.

Table 24. Analysis of Variance for Quality of Rooting of Softwood Olive Cuttings, 90 Days after Planting.

Source	D.F.	M.S. (well-rooted)	M.S. (poorly-rooted)
Planting Dates	19	482.5 xx	6.78
Growth Regulators	5	465.2 xx	6.4
Error	95	88.3	4.4

Table 25. Analysis of Variance for Percentage of Dead Softwood Olive Cuttings, 90 Days after Planting.

Source	D.F.	M.S.
Planting Dates	19	1652.6 xx
Growth Regulators	5	228.5
Error	95	131.0

xx Denotes F values significant at the 1% level.