RESEARCH ARTICLE **(Open Access)**

The Interaction of Season Collection of Cuttings, Indol Butyric Acid (IBA) and Juvenility Factors on Root Induction in *Olea europaea* L. Cultivar Kokërr Madhi i Beratit

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Abstract

Differences in the root ability of olive cuttings in the juvenile and mature form are reported. The root ability of cuttings from juvenile and mature olive shoots together with the influence of season stem collection and different concentration of IBA have been studied. The shoots coming from the olive ovule located at the base of the trunk are affected by juvenility factors. Leafy stem cuttings of olive cv. "Kokërr Madhi i Beratit" were obtained from 1-year-old olive shoots sampled on March 25th, April 15th, August 1st and September 1st during the 2013 growing season.

The shoots were collected from the olive ovule located at the base of the tree (juvenile form) and from canopy of the tree (mature form). To improve the rooting of olive cuttings, different concentrations of IBA, (0,2000,4000, 6000 and 10000 ppm) are applied.

The percentage of rooted cuttings sampled on March 25th and April 15th was markedly greater than those sampled on the other seasons (August 1st and September 1st). The concentration 4000 ppm of IBA was most effective. In all the seasons and concentrations of IBA the juvenility modified significantly higher rooting of cuttings.

Keywords: olive, root, shoot, juvenility, Indol Butyric Acid.

1. Introduction

The phase of juvenility characterizes the maximize of rooting capacity [4,6,7]. The increase of rooting capacity of cuttings of juvenile plants was probably due to the presence of large concentrations of auxins [1,2,3,6]. Shoot proliferation and rooting of the olive explants were improved by the addition to the nutrient media of 20 mg/l and 50 mg/l crude extract from olive ovule, respectively. Also, it was found that the extract of olive ovule has high content of IAA [4]. That means that shoots coming from the olive ovule located at the base of the tree have juvenility factors.

For some woody plants which are shy rooting, cuttings taken in the juvenile stage often root more easily than those taken from mature plants [6,8].

Olive, cv. "Kokërr Madhi i Beratit" is an important table variety for Albania. This also is one of the major difficulties with respect to vegetative propagation from leafy stem cuttings.

This experiment aimed the increase the rooting ability of olive cuttings of this variety using cuttings from different ontogenetic phases with different concentrations of IBA.

The difficulty in rooting certain cuttings can be due: 1-to the lack of a balanced hormonal level or of certain growth factors, 2-to the presence or absence of some growth inhibitors and to the presence or absence of anatomical features such as a ring of sclerenchyma which would make rooting easier if absent or discontinuous [8].

2. Material and Method

Leafy stem cuttings (15-20 cm long each) of olive cv. "Kokërr Madhi i Beratit" were obtained from 1-year-old olive shoots sampled on March 25th, April 15th, August 1st and September 1st during the 2013 growing season.

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The shoots were collected from the olive ovule located in the base of the tree (juvenile form) and from crown of the tree (mature form).

Leafy stem cuttings with four leaves were prepared in the morning and their bases were dipped for 7 seconds in solution of different concentration of IBA as follows:

Experiment one: March 25th

Cutting of Mature Form	Cuttings of Juvenile Form
1st treatment 0ppm IBA	1st treatment 0ppm IBA
2nd treatment 2000ppmIBA	2nd treatment 2000ppmIBA
3rd treatment 4000ppmIBA	3rd treatment 4000ppmIBA
4th treatment6000ppmIBA	4th treatment6000ppmIBA
5th treatment10000ppmIBA	5th treatment10000ppmIBA

Experiment two: April 15th

Cutting of Mature Form	Cuttings of Juvenile Form
1st treatment 0ppm IBA	1st treatment 0ppm IBA
2nd treatment 2000ppmIBA	2nd treatment 2000ppmIBA
3rd treatment 4000ppmIBA	3rd treatment 4000ppmIBA
4th treatment6000ppmIBA	4th treatment6000ppmIBA
5th treatment10000ppmIBA	5th treatment10000ppmIBA

Experiment three: August 1st

Cutting of Mature Form	Cuttings of Juvenile Form
1st treatment 0ppm IBA	1st treatment 0ppm IBA
2nd treatment 2000ppmIBA	2nd treatment 2000ppmIBA
3rd treatment 4000ppmIBA	3rd treatment 4000ppmIBA
4th treatment6000ppmIBA	4th treatment6000ppmIBA
5th treatment10000ppmIBA	5th treatment10000ppmIBA

Experiment four: September 1st

Cutting of Mature Form	Cuttings of Juvenile Form
1st treatment 0ppm IBA	1st treatment 0ppm IBA
2nd treatment 2000ppmIBA	2nd treatment 2000ppmIBA
3rd treatment 4000ppmIBA	3rd treatment 4000ppmIBA
4th treatment6000ppmIBA	4th treatment6000ppmIBA
5th treatment10000ppmIBA	5th treatment10000ppmIBA

After treatments, the stem cuttings were planted in greenhouse equipped with an automatic mist system. The layout of experimental design was completely randomized with 4 replications of 50 cuttings. Cuttings were evaluated 60 days after planting for percentage of rooted cuttings, primary root number and mean primary root length.

3. Results and discussion

Data in Table 1 show that the olive cv. “Kokërr Madhi i Beratit” is one of the major difficulties with respect to vegetative propagation from leafy stem cuttings. The percentage of rooting without IBA and with different concentrations of IBA was very low (11% maximum). The percentage of rooted cuttings sampled on March 25th and April 15th was markedly greater than those sampled on the other seasons (August 1st and September 1st). The concentration 4000 ppm of IBA was better. The effect of juvenility on root induction was significant in all the seasons and in all the concentration of IBA.

The combination of juvenility with concentration of 4000 ppp IBA and the month of April has the best results on root induction of cuttings of olive cultivar “Kokërr Madhi i Beratit”.

Table 1. Effect of season collection of cuttings, Indol Butyric Acid (IBA) and juvenility factors on root induction in *Olea europaea* L. cv. "Kokërr Madhi i Beratit"(the percentage of rooted cuttings)

Factor 1	Factor 2	Factor 3	r1	r2	r3	r4	Mean
Mature	March	0 IBA	2	0	0	2	**1**
		2000 ppm IBA	6	4	4	6	**5**
		4000 ppm IBA	6	8	12	10	**9**
		6000 ppm IBA	8	4	6	8	**6.5**
		10000 ppm IBA	4	6	2	8	**5**
	April	0 IBA	0	2	0	4	**1.5**
		2000 ppm IBA	4	6	4	0	**3.5**
		4000 ppm IBA	8	14	10	18	**12.5**
		6000 ppm IBA	14	16	8	10	**12**
		10000 ppm IBA	8	4	12	6	**7.5**
	August	0 IBA	2	0	0	2	**1**
		2000 ppm IBA	4	6	6	6	**5.5**
		4000 ppm IBA	8	6	8	4	**6.5**
		6000 ppm IBA	4	8	4	4	**5**
		10000 ppm IBA	4	6	4	6	**5**
	September	0 IBA	2	0	0	0	**0.5**
		2000 ppm IBA	4	0	0	2	**1.5**
		4000 ppm IBA	6	4	8	6	**6**
		6000 ppm IBA	6	4	4	4	**4.5**
		10000 ppm IBA	6	2	2	4	**3.5**
Juvenility	March	0 IBA	4	6	8	4	**5.5**
		2000 ppm IBA	14	10	18	10	**13**
		4000 ppm IBA	16	20	14	12	**15.5**
		6000 ppm IBA	16	12	8	18	**13.5**
		10000 ppm IBA	10	8	8	16	**10.5**
	April	0 IBA	8	4	6	2	**5**
		2000 ppm IBA	12	8	14	16	**12.5**
		4000 ppm IBA	18	16	14	16	**16**
		6000 ppm IBA	10	12	18	16	**14**
		10000 ppm IBA	12	16	8	12	**12**
	August	0 IBA	2	0	4	4	**2.5**
		2000 ppm IBA	6	8	6	4	**6**
		4000 ppm IBA	10	12	8	6	**9**
		6000 ppm IBA	8	10	6	14	**9.5**
		10000 ppm IBA	6	8	4	10	**7**
	Semptember	0 IBA	4	0	2	0	**1.5**
		2000 ppm IBA	8	10	6	10	**8.5**
		4000 ppm IBA	4	10	8	8	**7.5**
		6000 ppm IBA	10	6	6	10	**8**
		10000 ppm IBA	4	6	8	4	**5.5**

Table 2. Variance table (Three Factorial Analysis, percentage of rooted cuttings)

VS	DF	SS	MS	F
Factor1-F1	1	640.00000	640.00000	98.2097 **
Factor2-F2	3	641.70000	213.90000	32.8235 **
Factor3-F3	4	1183.25000	295.81250	45.3932 **
Int. F1xF2	3	97.80000	32.60000	5.0026 **
Int. F1xF3	4	55.75000	13.93750	2.1387 ns
Int. F2xF3	12	124.55000	10.37917	1.5927 ns
Int.F1x2x3	12	80.45000	6.70417	1.0288 ns
Treatments	39	2823.50000	72.39744	11.1096 **
Error	120	782.00000	6.51667	
Total	159	3605.50000		

** Significative at a level of 1% of probability ($p < .01$)

* Significative at a level of 5% of probability ($.01 =< p < .05$)

ns Non-significative ($p >= .05$)

Data in Table 3 show that the combination of season collection of cuttings, Indol Butyric Acid (IBA) and juvenility factors marked differences in the mean root number per cuttings. The root number per cuttings was statistically higher (3,75 roots per cutting) on cuttings sampled on April 15th from shoots in juvenile form. The best concentration of IBA was 4000 ppm. This might be due to the more appropriate temperatures on this season.

Table 3. Effect of season collection of cuttings, Indol Butyric Acid (IBA) and juvenility factors on mean root number per cutting

Factor 1	Factor 2	Factor 3	r1	r2	r3	r4	Mean
Mature	March	0 IBA	2	0	0	2	**1**
		2000 ppm IBA	2	1.5	1.5	2.62	**1.905**
		4000 ppm IBA	2.66	2	2.17	2.2	**2.2575**
		6000 ppm IBA	2.25	1.5	3	3.62	**2.5925**
		10000 ppm IBA	3.25	2.83	2.5	2	**2.645**
	April	0 IBA	0	2	0	1.5	**0.875**
		2000 ppm IBA	2.33	2.17	2.33	0	**1.7075**
		4000 ppm IBA	2.37	2.62	2.2	1.88	**2.2675**
		6000 ppm IBA	2.06	2.83	2.16	2.1	**2.2875**
		10000 ppm IBA	2.66	2.18	2.5	2.12	**2.365**
	August	0 IBA	1	0	0	1	**0.5**
		2000 ppm IBA	1.5	2.67	2	2.75	**2.23**
		4000 ppm IBA	2.25	2	2.33	3	**2.395**
		6000 ppm IBA	3.5	1.8	1.5	3	**2.45**
		10000 ppm IBA	1.8	2.33	2.2	2	**2.0825**
	September	0 IBA	2	0	0	0	**0.5**
		2000 ppm IBA	1.75	0	1.75	2	**1.375**
		4000 ppm IBA	1.83	2	2.12	2.16	**2.0275**
		6000 ppm IBA	1.83	1.75	2.25	2	**1.9575**
		10000 ppm IBA	2.16	1.5	2	2.25	**1.9775**
Juvenility	March	0 IBA	2	2.33	2.5	1.5	**2.0825**
		2000 ppm IBA	2.28	3.2	2.77	2.4	**2.6625**
		4000 ppm IBA	2.12	2.9	2.14	2.33	**2.3725**
		6000 ppm IBA	2	2.17	1.75	2.44	**2.09**
		10000 ppm IBA	2.3	2.37	2.25	2.33	**2.3125**
	April	0 IBA	2.8	3	3.65	2	**2.8625**
		2000 ppm IBA	2.5	2.75	2.28	3	**2.6325**
		4000 ppm IBA	3.66	3.87	3.85	3.63	**3.7525**

Factor 1	Factor 2	Factor 3	r1	r2	r3	r4	Mean
		6000 ppm IBA	2.8	2.83	2.87	2.77	**2.8175**
		10000 ppm IBA	3.08	2.06	2.62	2.33	**2.5225**
	August	0 IBA	3	0	2	1.5	**1.625**
		2000 ppm IBA	3.66	2.28	2.8	2.5	**2.81**
		4000 ppm IBA	2.78	2.55	2.57	2.25	**2.5375**
		6000 ppm IBA	2.2	1.67	2.6	2.28	**2.1875**
		10000 ppm IBA	2.33	2.12	2.25	2.2	**2.225**
	September	0 IBA	1.5	0	2	0	**0.875**
		2000 ppm IBA	1.75	2.2	2.33	2.4	**2.17**
		4000 ppm IBA	2	2.4	2	2.4	**2.2**
		6000 ppm IBA	2.25	1.8	2.33	1.67	**2.0125**
		10000 ppm IBA	2.6	2.25	1.83	2.12	**2.2**

Table 4. Variance table (Three Factorial Analysis, mean root number per cutting **)**

VS	DF	SS	MS	F
Factor1-F1	1	9.14414	9.14414	25.7038 **
Factor2-F2	3	9.63062	3.21021	9.0238 **
Factor3-F3	4	28.16605	7.04151	19.7934 **
Int. F1xF2	3	3.95297	1.31766	3.7039 *
Int. F1xF3	4	7.85952	1.96488	5.5232 **
Int. F2xF3	12	5.02998	0.41916	1.1783 ns
Int.F1x2x3	12	3.05835	0.25486	0.7164 ns
Treatments	39	66.84163	1.71389	4.8177 **
Error	120	42.69008	0.35575	
Total	159	109.53171		

** Significative at a level of 1% of probability ($p < .01$)

* Significative at a level of 5% of probability ($.01 =< p < .05$)

ns Non-significative ($p >= .05$)

Increasing the rooting capacity of cuttings of juvenile phase reported in this paper is in accord with the findings of other researchers [3,5,6,7,8]. The juvenile form that enhanced the number of roots on cuttings of olive probably due to the presence of large concentrations of auxins. Rama [4] confirmed that the extract of olive ovule has high content of IAA.

4. Conclusions

The percentage of rooted cuttings sampled on March 25th and April 15th was markedly greater than those sampled on the other seasons (August 1st and September 1st). The concentration 4000 ppm of IBA was most effective. The rooting process of cuttings as the key to success for the mist propagation of olive trees, is characterized and influenced by a number of factors. The auxins are promoters of processes and molecular mechanisms which by their actions lead to the formation of adventives roots. The effectiveness of their use depends not only on the recognition of genetype behavior toward rhizogenesis but also on the plant vegetative stage where the cuttings are taken from. Their physiological condition is related to their ontogenetic age and other changes along the vegetative development. In all the seasons and the concentrations of IBA the juvenility modified significantly higher rooting of cuttings. The best rooting ability of cuttings taken from saplings in juvenile age is also connected with other promoting factors and substances which in cooperation and addition with IBA stimulation bring about and make it possible to achieve economic satisfactory results in the mist propagation of olive trees with poor rooting ability.

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