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Water soaking duration, Indole butyric acid and rooting media and their effect on rooting ability of Ramsey grapevine rootstock cuttings

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ABSTRACT

This research was carried out to investigate the effects of soaking cuttings in water, rooting hormone (IBA) anddifferent rooting media on rooting ability of Ramsey grapevine rootstock cuttings. For this purpose, cuttings were taken at January in 2013 and 2014 years from the Production Sector Farms of the Egyptian Ministry of Agriculture. The collected cuttings soaked in water (12 or 24 hour) then treated with indole butyric acid (IBA) at 500 or 1000 ppm. The cuttings were planted into six rooting media (sand, peat moss, sawdust, sand + peat moss, sand + sawdust and sand+ peat moss+ sawdust). Two months later the observations were done. The rooting percentage, roots number, root weight, root length, shoot length and shoot diameter were determined during the study. According to obtained results, the best rooting performance was obtained from 500 ppm IBA application after soaking the cuttings for 24 hour then planted in mixture of sand, peat moss and sawdust. The water soaking treatment (12 hour) and IBA (1000 ppm) application stimulated rooting of cuttings but less rate than pervious treatment. Lowest results of rooting were obtained from control.

Key words: Ramsey grapevine, rooting hormone, rootstock,

Introduction

Grape rootstocks produced from many different Vitis species have been a major part of grape growing around the world due to their superior characteristics against biotic and a biotic stress factors.However, not all the rootstocks come with free of concern. They are resistance to nematodes or grow poorly in lime or calcareous soils. In the rootstocks propagation, the most common problem encountered is for some rootstocks to root poorly (Reynolds and Wordle 2001).

Ramsey is thought to be a natural hybrid between V. candicans and V. rupestris and selected the V. champinii, it induces very high vigor in scions. This rootstock is well suited to low fertility, coarse-textured soils, deep roots, high drought, salt tolerance and it has strong resistance to root-knot nematodes and moderate resistance to dagger nematode (Walker *et al.,* 2002 and Ozden *et al.,* 2010).

Ramsey rootstock have been known hard to root. Many different ways to induce rooting of grape rootstocks have been tried with different success over the course of grape growing. For instance, plant growth regulators have been the most commonly used for this purpose. Auxins are known to increase rooting percentage and rooting time together with uniformity of rooting (Hartmann *et al.,* 2002).

Research evidence suggests that auxins play a central role in the determination of rooting capacity, by enabling the faster production of rooted cutting material which is essential for vegetative propagation (Fogaça and Fett-Neto, 2005).

Cuttings without root lack effective organs to replace transpired water loss and cells must maintain adequate turgor for initiation and development of roots (Hartmann *et al.,* 1997). Soaking cuttings in water before grafting is commonly performed in the nurseries with varying durations to ease grafting and induce callus formation at the graft zone. Soaking in water treatment has been also used by Gökbayrak *et al.* (2010) ,they found that dipping cuttings of 41B in auxin solution after water soaking for 24 hours caused an increase in root growth (development, weight and rooting) of the grafting cuttings.

The rooting media is important in successful propagation of cuttings. The media can influence the percentage of cuttings that root and the type of root system developed (Celik, 1998). A good

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media provides several essential functions: it holds the cuttings in place, it maintains a high moisture content yet is well drained, it allows adequate air exchange around the base of the cutting, (Hartmann *et al.,* 1968).

This study aims to conduct production of cuttings by use of a different methods for rooting of cuttings by determine the best duration for water soaking, the optimum concentration of indole butyric acid (IBA) and the most appropriate media to induce adventitious root formation of Ramsey grape rootstock cuttings .

Materials and Methods

The experiment was carried out during two successive seasons 2013 and 2014 at the private nursery at Ahmed Orabi Association, Cairo Ismailia Desert Road. Healthy, dormant cuttings (approximately 8 mm diameter) of Ramsey (Vitischampanii) rootstock were taken at January from the Production Sector Farms of the Egyptian Ministry of Agriculture.

The design was complete randomized. Treatments were 2 soaking in water, 2 concentrations of IBA and six planting media factorial, and their combination.

The cuttings were kept in a black polyethylene bag in a cold storage room under 5 ºC and 80% relative humidity for one month, then removed from cold storage and surface sterilized by 0.1% $NaClO_3$. Thereafter, cuttings were divided in three sections. First section was for soaking in water for 12 hours and the second section for 24 hours, the 3 rd one without soaking.

Cuttings were cut to 3-bud each prior to planting. Three concentration of indole butyric acid (IBA) were used, 0, 500, 1000 ppm. The treatment was performed by dipping the base of cuttings in the (IBA) solutions for 20 seconds. The cuttings were then planted into the rooting media. The media were kept moist by frequent watering to provide a humid environment around the cuttings

Cuttings were planted in black polyethylene bags (15 cm x 20 cm) filled with six rooting media as follows: sand, peat moss, sawdust, mixture of sand and peat moss in equal ratio, mixture of sand and sawdust in equal ratio and mixture of sand, peat moss and sawdust in equal ratio.

After planting the cuttings in different media, the plastic bags containing the cuttings were kept in the plastic covered frames which were structured to create conditions suitable for rooting of the cuttings. The frames were covered with white transparent plastic film to maintain optimum relative humidity around the cuttings. The plastic covered frame was placed under greenhouse 50% shaded.
After two months of growth under greenhouse, rooting percentage, number of roots, root weight (g), root length (cm), shoot length (cm) and shoot diameter were recorded .The study was conducted in a randomized blocks design with 3 replicates and 15 cuttings per replicate.

Statistical analysis

The statistical analysis of the present data was carried out according to Snedecor and Cochran (1980). Averages were compared using L.S.D. values at 5% level.

Results

The present experiment was planned to study the efficiency of application of water soaked, indole butyric acid (IBA) and different rooting media and their effect on rooting of cuttings, in the two studied seasons(2013 and 2014).

Rooting Percentage

Data in table (1and 2) show that effects of soaking cuttings in water, different rooting media, and application of (IBA) on rooting percentage for Ramsey cuttings in the two seasons.
Regarding effect of soaking treatment, data indicated that soaking treatment significantly increased rooting percentage of cuttings in comparison to that of control in the two seasons. Soaking cuttings 24 hours resulted in higher rooting percentage (79.53 and 81.24) followed by 12 hours (76.04 and 72.45) respectively, in the 1st and 2nd seasons.

With respect to the effect of IBA, it is clear that it had a positive effect on rooting percentage. IBA at 500 ppm significantly increased rooting % (83.90 and 84.42) followed by 1000 ppm (73.66 and 72.19), whereas control had recorded the lowest rooting percentage (67.30 and 64.01) respectively in both seasons.

Concerning the effect of rooting media, it obvious that rooting % differed according to type of rooting media. The rooting media (sand+ peatmoss + sawdust) gave the highest rooting percentage (83.35 and 82.84) followed by mixture of sand and sawdust (81.64and 80.53), while the lowest rooting percentage was in peat moss (65.65and 62.13) respectively, in 2013 and 2014 seasons.

Regarding the effect of the interaction between soaking in water and IBA, cuttings that were treated with 500 ppm IBA after soaking in water for 24 hours showed the highest percentage of rooting(88.46 and 91.00), followed by those treated with 1000 ppm, compared to control respectively, in 2013 and 2014 seasons.

As for the effect of interaction between soaking in water and rooting media, soaking in water for 24 hours then planting in mixture of sand, peatmoss and sawdust as rooting media had significantly the highest percentage of rooting (94.66 and 95.25) respectively, in 2013 and 2014 seasons.

With respect to the effect of interaction between IBA and rooting media, the highest significant percentage of rooting 88.89 and 88.51 respectively in 2013 and 2014 seasons was resulted from cuttings which planted in mixture of sand+ peatmoss + sawdust after treated with IBA at 500 ppm.

The interaction of the three factors soaking in water, IBA and rooting media showed better results. Cuttings treated with 500 ppm of IBA and soaked in water for 24 hours then planted in mixture of sand+ peatmoss + sawdust as significantly had the highest percentage of rooting (94.66 and 95.25), respectively, in 2013 and 2014 seasons.

Number of Roots

Data in table (3 and 4) show that effect of soaking cuttings in water, different rooting media, and application of rooting hormone (IBA) on number of roots for Ramsey grapevine rootstock cuttings in the two seasons.

Regarding effect of soaking treatment, data indicated that soaking treatment had significantly increased number of roots in comparison to that of control in the two studied seasons. Soaking cuttings 24 hours showed significantly increased number of roots (8.82 and 8.89) followed by 12 hours (8.00 and 8.17) respectively, in 2013 and 2014.

The effect of IBA, followed the same trend. The positive effect of IBA on number of roots compared to control is obvious. IBA at 500 ppm showed significant higher number of roots (8.94 in the 1st and 8.46 in the 2nd season).followed by IBA at 1000 ppm (7.04 and 6.90), respectively, in both seasons.

Concerning the effect of rooting media, it is obvious that number of roots differed according to type of rooting media. The rooting media (sand+ peatmoss + sawdust) gave higher number of roots (9.71 and 10.12) followed by mixture of sand and sawdust (8.41 and 8.27), while the lowest number of roots was in peat moss (5.31 and 5.17) respectively, in 2013 and 2014 seasons.

Regarding the effect of interaction between soaking in water and IBA, the highest significant number of roots (11.16 and 10.67) was recorded from cuttings soaked in water for 24 hours then treated with IBA at 500 ppm, while the treatment of control (0 IBA + no soaking) gave the lowest number of roots (4.43 and 3.74) respectively, in 2013 and 2014 seasons.

As for the effect of interaction between soaking in water and rooting media, planting cuttings in mixture of sand+ peatmoss + sawdust after soaked in water for 24 hours significantly had the highest number of roots (11.66 and 11.62) respectively, in 2013 and 2014 seasons.

The effect of interaction between (IBA)and rooting media, recorded significant number of roots (11.58 and 11.62) respectively in 2013 and 2014 seasons resulted from treated cuttings with IBA at 500 ppm and cultivated in mixture of sand+ peatmoss + sawdust.

In addition, cuttings treated with 500 ppm of IBA after soaking in water for 24 hours then planting in mixture of sand, peatmoss and sawdust as rooting media significantly had the highest number of roots (13.85 and 14.73), whereas the lowest number of roots (2.63 and 2.51) was attained by cuttings planting in peatmoss as a rooting media without soaking or IBA .

Table1. Effects of water soaking, IBA application and rooting media on rooting percentage of Ramsey rootstock cuttings in 2013 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	86.35	70.25	66.15	**74.25**	84.94	72.72	75.13	**77.60**	78.1	66.95	59.85	**68.28**
Peat (A2)	76.15	71.35	51.25	**66.25**	86.13	58.33	66.80	**70.42**	67.9	68.05	44.95	**60.28**
Sawdust (A3)	84.35	70.58	61.36	**72.10**	85.25	68.05	73.86	**75.72**	76.1	67.28	45.06	**62.80**
sand + peat (A4)	88.35	72.35	66.03	**75.58**	87.12	72.93	75.68	**78.58**	80.1	69.05	67.95	**72.35**
sand+sawdust (A5)	89.25	79.25	80.15	**82.88**	92.67	91.02	75.77	**86.49**	81	75.95	69.73	**75.54**
sand+peat+sawdust (A6)	90.15	81.15	84.25	**85.18**	94.66	92.82	77.58	**88.35**	81.9	77.85	69.85	**76.52**
MEANS (BxC)	**85.8**	**74.2**	**68.2**		**88.5**	**76.0**	**74.1**		**77.5**	**70.9**	**59.6**	
MEANS (B)		**76.04**				**79.53**				**69.30**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	83.11	69.97	67.04	**73.38**
Peat (A2)	76.71	65.91	54.33	**65.65**
Sawdust (A3)	81.88	68.64	60.09	**70.20**
sand + peat (A4)	85.17	71.44	69.89	**75.50**
sand+sawdust (A5)	87.62	82.07	75.22	**81.64**
sand+peat+sawdust (A6)	88.89	83.94	77.23	**83.35**
MEANS (C)	**83.90**	**73.66**	**67.30**	

L.S.D 0.05 for

(A) =	1.63
(B) =	1.15
(C) =	1.15
(AxB) =	2.82
(AxC) =	2.82
(BxC) =	2.00
(AxBxC) =	4.89

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Table 2. Effects of water soaking , IBA application and rooting media on rooting percentage of Ramsey rootstock cuttings in 2014 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	86.94	62.62	62.68	**70.75**	91.33	81.45	63.25	**78.68**	76.7	63.73	58.32	**66.26**
Peat (A2)	76.83	47.9	61.92	**62.22**	81.25	80.35	48.35	**69.98**	66.4	62.54	33.60	**54.18**
Sawdust (A3)	85.03	57.95	62.26	**68.41**	90.35	80.68	61.46	**77.50**	74.6	62.85	53.65	**63.71**
sand + peat (A4)	88.92	62.83	62.9	**71.55**	93.45	82.45	73.13	**83.01**	78.7	64.72	58.53	**67.33**
sand+sawdust (A5)	89.48	80.92	69.66	**80.02**	94.35	89.35	81.35	**88.35**	79.6	71.63	68.42	**73.22**
sand+peat+sawdust (A6)	89.84	82.72	72.74	**81.77**	95.25	91.25	83.25	**89.92**	80.4	73.44	76.62	**76.83**
MEANS (BxC)	**86.2**	**65.8**	**65.4**		**91.0**	**84.3**	**68.5**		**76.1**	**66.5**	**58.2**	
MEANS (B)	**72.45**				**81.24**				**66.92**			

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	85.00	69.27	61.42	**71.89**
Peat (A2)	74.83	63.60	47.96	**62.13**
Sawdust (A3)	83.33	67.16	59.12	**69.87**
sand + peat (A4)	87.03	70.00	64.85	**73.96**
sand+sawdust (A5)	87.82	80.63	73.14	**80.53**
sand+peat+sawdust (A6)	88.51	82.47	77.54	**82.84**
MEANS (C)	**84.42**	**72.19**	**64.01**	

L.S.D 0.05 for

(A) =	2.30
(B) =	1.62
(C) =	1.62
(AxB) =	3.98
(AxC) =	3.98
(BxC) =	2.81
(AxBxC) =	6.89

Table 3. Effects of water soaking , IBA application and rooting media on roots number of Ramsey rootstock cuttings in 2013 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	9.25	7.45	6.18	**7.63**	10.65	7.65	6.32	**8.21**	5.45	4.42	3.55	**4.47**
Peat (A2)	7.85	4.55	4.25	**5.55**	9.25	6.25	5.15	**6.88**	4.38	3.48	2.63	**3.50**
Sawdust (A3)	8.78	7.23	5.75	**7.25**	10.18	7.18	6.04	**7.80**	4.55	4.35	3.88	**4.26**
sand + peat (A4)	9.65	7.56	6.85	**8.02**	11.05	8.05	7.07	**8.72**	5.75	4.95	4.71	**5.14**
sand+sawdust (A5)	10.55	9.35	7.85	**9.25**	11.95	8.95	7.94	**9.61**	6.88	5.95	6.25	**6.36**
sand+peat+sawdust (A6)	12.45	10.05	8.45	**10.32**	13.85	11.85	9.29	**11.66**	8.45	7.45	5.55	**7.15**
MEANS (BxC)	**9.76**	**7.70**	**6.56**		**11.16**	**8.32**	**6.97**		**5.91**	**5.10**	**4.43**	
MEANS (B)		**8.00**				**8.82**				**5.15**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	8.45	6.51	5.35	**6.77**
Peat (A2)	7.16	4.76	4.01	**5.31**
Sawdust (A3)	7.84	6.25	5.22	**6.44**
sand + peat (A4)	8.82	6.85	6.21	**7.29**
sand+sawdust (A5)	9.79	8.08	7.35	**8.41**
sand+peat+sawdust (A6)	11.58	9.78	7.76	**9.71**
MEANS (C)	**8.94**	**7.04**	**5.98**	

L.S.D 0.05 for

(A) =	1.30
(B) =	0.81
(C) =	1.90
(AxB) =	8.17
(AxC) =	7.57
(BxC) =	6.73
(AxBxC) =	11.22

Table 4. Effects of water soaking, IBA application and rooting media on roots number of Ramsey rootstock cuttings in 2014 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	8.00	6.90	6.55	**7.15**	9.60	8.45	6.67	**8.24**	4.90	3.44	2.78	**3.71**
Peat (A2)	7.14	5.91	5.10	**6.05**	8.22	4.88	5.51	**6.20**	4.60	2.65	2.51	**3.25**
Sawdust (A3)	7.54	6.92	6.10	**6.85**	9.14	8.32	6.41	**7.96**	4.25	3.25	2.72	**3.41**
sand + peat (A4)	8.38	7.20	9.37	**8.32**	10.50	8.12	6.94	**8.52**	5.77	5.06	3.82	**4.88**
sand+sawdust (A5)	10.90	8.82	8.91	**9.54**	11.82	10.41	8.31	**10.18**	6.62	4.33	4.30	**5.08**
sand+peat+sawdust (A6)	12.81	10.22	10.20	**11.08**	14.73	13.43	10.17	**12.78**	7.32	5.91	6.33	**6.52**
MEANS (BxC)	**9.13**	**7.66**	**7.71**		**10.67**	**8.94**	**7.34**		**5.58**	**4.11**	**3.74**	
MEANS (B)		**8.17**				**8.98**				**4.48**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	7.50	6.26	5.33	**6.37**
Peat (A2)	6.65	4.48	4.37	**5.17**
Sawdust (A3)	6.98	6.16	5.08	**6.07**
sand + peat (A4)	8.22	6.79	6.71	**7.24**
sand+sawdust (A5)	9.78	7.85	7.17	**8.27**
sand+peat+sawdust (A6)	11.62	9.85	8.90	**10.12**
MEANS (C)	**8.46**	**6.90**	**6.26**	

L.S.D 0.05 for

(A) = 1.86
(B) = 0.81
(C) = 1.56
(AxB) = 9.52
(AxC) = 7.25
(BxC) = 6.93
(AxBxC) = 12.22

Root Fresh Weight

Data in table (5 and 6) show that effects of different rooting media, soaking cuttings in water and rooting hormone (IBA) on root weight for Ramsey grapevine rootstock cuttings in the two seasons.

Soaking cuttings of Ramsey rootstock in water produced heavier root in compared to control in the two studied seasons. Cuttings which were soaked for 24 hours showed significant increase in root weight (1.16 and 1.17) followed by 12 hours (0.86 and 0.82). On the contrary, control had recorded the lowest root weight (0.74 and -0.72) respectively, in the two seasons.

With respect to the effect of IBA, it is clear that it had positive effect on root weight compared to control. IBA at 500 ppm showed significant increase in root weight (1.18 and1.16).followed by IBA at 1000 ppm (0.88 and 0.83).

Concerning the effect of rooting media, itobvious that root weight differed according to kind of rooting media. The rooting media (sand+ peatmoss + sawdust) gave the highest root weight (1.56 and 1.55) followed by mixture of sand and sawdust (1.03and 0.97), while the lowest root weight was in peat moss (0.65 and 0.62) in 2013 and 2014 seasons respectively.

Regarding the effect of interaction between soaking in water and IBA, the significant root weight (1.42 and 1.45) was obtained from cuttings soaked in water for 24 hours then treated with IBA at 500 ppm ,while the control treatment (0 IBA + no soaking) gave the lowest root weight (0.56 and 0.58) respectively in 2013 and 2014 seasons.

Soaking cuttings in water for 24 hours then planted in the media (sand+ peatmoss + sawdust) had significantly increased root weight (1.83 and 1.81) compared to other treatments respectively, in 2013 and 2014 seasons.-

The effect of interaction between indole butyric acid and rooting media, significantly increased root weight, cuttings planted in sand+ sawdust+ peat moss media after treated with IBA at 500 ppm gave 1.76 g in 2013 and 1.73 g in 2014.

With regard to effect of interaction among soaking in water, indole butyric acid (IBA) and rooting media, cuttings treated with 500 ppm of IBA after soaking in water for 24 hours then planting in mixture of sand, peatmoss and sawdust as rooting media significantly increased root weight (1.98 and 2.05), whereas the lowest root weight (0.34 and 0.30) was attained by cuttings planted in peat moss without water soaking or IBA respectively, in 2013 and 2014 seasons.

Length of root

Data in table (7 and 8) show that effects of different rooting media, soaking cuttings in water and (IBA) on root length for cuttings in the two seasons.

The effect of soaking treatment, data indicated that soaking significantly increased root length of cuttings in comparison to that of unsoaked cuttings in the two studied seasons. Soaking cuttings for 24 hours showed significant effect in root length (9.73 and 9.44) followed by 12 hours (7.91 and 8.35). On the contrary, control had recorded the lowest root length (6.74 and 6.38) in the two seasons respectively.

IBA, positively affect root length compared to control. IBA at 500 ppm showed significantly raised root length (9.67 and 9.29).followed by IBA at 1000 ppm (7.38 and 7.40) respectively, in both seasons.

Concerning effect of rooting media, it obvious that root length differed according to type of rooting media. The rooting media (sand+ peatmoss + sawdust) gave the highest root length (12.62 and 13.10) followed by mixture of sand and sawdust (9.93 and 10.43), while the lowest root length was in peat moss (5.36 and 5.02) in 2013 and 2014 seasons respectively.

Regarding the effect of interaction between soaking in water and IBA, significant root length (11.33 and 10.69) was observed from cuttings soaked in water for 24 hours then treated with IBA 500 ppm ,while the treatment of control (0 IBA + no soaking) gave the lowest root length (5.94 and 5.85) respectively, in 2013 and 2014 seasons.

As for the effect of interaction between soaking in water and rooting media, soaking cuttings in water for 24 hours then planted in rooting media (sand+ peatmoss + sawdust) significantly had the highest root length (14.55 and 14.41) respectively, in 2013 and 2014 seasons.

Table 5. Effects of water soaking , IBA application and rooting media on root weight of Ramsey rootstock cuttings in 2013 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	1.18	0.74	0.43	**0.78**	1.38	0.88	0.86	**1.04**	0.61	0.55	0.43	**0.53**
Peat (A2)	0.80	0.41	0.43	**0.55**	1.15	0.85	0.86	**0.95**	0.46	0.51	0.34	**0.44**
Sawdust (A3)	0.94	0.57	0.39	**0.63**	1.01	0.83	0.62	**0.82**	0.88	0.48	0.54	**0.63**
sand + peat (A4)	1.23	0.67	0.50	**0.80**	1.42	0.82	0.73	**0.99**	0.84	0.55	0.41	**0.60**
sand+sawdust (A5)	1.37	0.88	0.64	**0.96**	1.57	1.23	1.13	**1.31**	1.03	0.98	0.49	**0.83**
sand+peat+sawdust (A6)	1.82	1.44	1.10	**1.45**	1.98	1.93	1.57	**1.83**	1.49	1.60	1.14	**1.41**
MEANS (BxC)	**1.22**	**0.79**	**0.58**		**1.42**	**1.09**	**0.96**		**0.88**	**0.78**	**0.56**	
MEANS (B)		**0.86**				**1.16**				**0.74**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	1.06	0.72	0.57	**0.78**
Peat (A2)	0.81	0.59	0.54	**0.65**
Sawdust (A3)	0.94	0.63	0.52	**0.70**
sand + peat (A4)	1.16	0.68	0.55	**0.80**
sand+sawdust (A5)	1.32	1.03	0.75	**1.03**
sand+peat+sawdust (A6)	1.76	1.66	1.27	**1.56**

L.S.D 0.05 for

(A) =	0.53
(B) =	0.29
(C) =	0.29
(AxB) =	1.39
(AxC) =	1.22
(BxC) =	0.86
(AxBxC) =	1.64

Table 6. Effects of water soaking, IBA application and rooting media on root weight of Ramsey rootstock cuttings in 2014 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	0.90	0.48	0.43	**0.60**	1.19	0.84	0.86	**0.96**	0.58	0.52	0.54	**0.55**
Peat (A2)	0.76	0.44	0.43	**0.54**	1.04	0.81	0.86	**0.90**	0.44	0.49	0.30	**0.41**
Sawdust (A3)	1.17	0.40	0.39	**0.65**	1.45	0.77	0.62	**0.95**	0.85	0.45	0.54	**0.61**
sand + peat (A4)	1.13	0.63	0.54	**0.77**	1.41	0.97	0.73	**1.04**	0.91	0.62	0.41	**0.65**
sand+sawdust (A5)	1.32	0.67	0.66	**0.88**	1.59	1.17	1.07	**1.28**	1.00	0.75	0.46	**0.74**
sand+peat+sawdust (A6)	1.73	1.51	1.14	**1.46**	2.05	1.84	1.53	**1.81**	1.41	1.52	1.21	**1.38**
MEANS (BxC)	**1.17**	**0.69**	**0.60**		**1.45**	**1.07**	**0.95**		**0.87**	**0.73**	**0.58**	
MEANS (B)		**0.82**				**1.16**				**0.72**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	0.89	0.61	0.61	**0.70**
Peat (A2)	0.75	0.58	0.53	**0.62**
Sawdust (A3)	1.16	0.54	0.52	**0.74**
sand + peat (A4)	1.15	0.74	0.56	**0.82**
sand+sawdust (A5)	1.30	0.86	0.73	**0.97**
sand+peat+sawdust (A6)	1.73	1.62	1.29	**1.55**
MEANS (C)	**1.16**	**0.83**	**0.71**	

L.S.D 0.05 for

(A) =	0.58
(B) =	0.35
(C) =	0.34
(AxB) =	1.40
(AxC) =	1.20
(BxC) =	0.88
(AxBxC) =	1.75

Table7. Effects of water soaking , IBA application and rooting media on root length of Ramsey rootstock cuttings in 2013 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	7.77	7.57	6.97	**7.44**	9.43	8.43	8.83	**8.90**	6.18	5.38	4.58	**5.38**
Peat (A2)	5.19	5.81	5.39	**5.46**	7.25	6.15	7.25	**6.88**	4.10	3.80	3.30	**3.73**
Sawdust (A3)	7.49	6.15	4.21	**5.95**	9.15	8.35	4.75	**7.42**	6.30	4.90	4.60	**5.27**
sand + peat (A4)	8.68	7.81	5.86	**7.45**	9.85	8.58	7.86	**8.76**	7.26	5.65	4.82	**5.91**
sand+sawdust (A5)	10.61	7.09	9.83	**9.18**	12.15	10.35	13.03	**11.84**	9.30	7.33	9.66	**8.76**
sand+peat+sawdust (A6)	16.19	9.59	10.09	**11.96**	20.15	11.55	11.95	**14.55**	17.00	8.40	8.70	**11.37**
MEANS (BxC)	**9.32**	**7.34**	**7.06**		**11.33**	**8.90**	**8.95**		**8.36**	**5.91**	**5.94**	
MEANS (B)		**7.91**				**9.73**				**6.74**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	7.79	7.13	6.79	**7.24**
Peat (A2)	5.51	5.25	5.31	**5.36**
Sawdust (A3)	7.65	6.47	4.52	**6.21**
sand + peat (A4)	8.60	7.35	6.18	**7.37**
sand+sawdust (A5)	10.69	8.26	10.84	**9.93**
sand+peat+sawdust (A6)	17.78	9.85	10.25	**12.62**
MEANS (C)	**9.67**	**7.38**	**7.32**	

L.S.D 0.05 for

(A) =	2.70
(B) =	1.82
(C) =	2.29
(AxB) =	10.82
(AxC) =	12.47
(BxC) =	5.39
(AxBxC) =	16.85

Table 8. Effects of water soaking , IBA application and rooting media on root length of Ramsey rootstock cuttings in 2014 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	7.45	7.45	6.85	**7.3**	7.99	8.19	7.59	**7.9**	4.74	4.94	4.20	**4.63**
Peat (A2)	5.75	5.05	5.95	**5.6**	6.69	5.59	8.01	**6.8**	3.24	2.74	2.16	**2.71**
Sawdust (A3)	8.05	6.85	3.45	**6.1**	8.59	9.11	4.05	**7.3**	5.74	4.34	3.54	**4.54**
sand + peat (A4)	8.78	7.05	6.56	**7.5**	9.15	7.88	8.62	**8.6**	6.56	6.06	4.12	**5.58**
sand+sawdust (A5)	11.05	8.85	11.73	**10.5**	12.91	9.79	12.47	**11.7**	10.06	6.63	10.42	**9.04**
sand+peat+sawdust (A6)	15.95	11.55	11.85	**13.1**	18.79	12.05	12.39	**14.4**	15.64	9.04	10.66	**11.78**
MEANS (BxC)	**9.51**	**7.80**	**7.73**		**10.69**	**8.77**	**8.86**		**7.66**	**5.63**	**5.85**	
MEANS (B)		**8.35**				**9.44**				**6.38**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	6.73	6.86	6.21	**6.60**
Peat (A2)	5.23	4.46	5.37	**5.02**
Sawdust (A3)	7.46	6.77	3.68	**5.97**
sand + peat (A4)	8.16	7.00	6.43	**7.20**
sand+sawdust (A5)	11.34	8.42	11.54	**10.43**
sand+peat+sawdust (A6)	16.79	10.88	11.63	**13.10**
MEANS (C)	**9.29**	**7.40**	**7.48**	

L.S.D 0.05 for

(A) =	2.67
(B) =	1.09
(C) =	1.89
(AxB) =	11.70
(AxC) =	11.42
(BxC) =	4.84
(AxBxC) =	16.63

With respect to the effect of interaction between indole butyric acid (IBA)and rooting media, significant root length (17.78 and 16.79) was achieved when cuttings planted in rooting media (sand+ peatmoss + sawdust) after treated with IBA at 500 ppm then, while the treatment of control (0 IBA + no soaking) gave the lower root length (5.31 and 5.37) respectively, in 2013 and 2014 seasons.
Cuttings treated with 500 ppm of IBA after soaking in water for 24 hours then planting in mixture of sand, peatmoss and sawdust as rooting media significantly had the highest root length (20.15 and 18.79), whereas the lowest root length (3.30 and 2.16) as a result of planting in peatmoss without water soaking or IBA.

Length of shoot

Data in table (9 and 10) show that effects of different rooting media, soaking cuttings in water and IBA on shoot length for Ramsey grapevine rootstock cuttings in the two seasons.
Regarding effect of soaking treatment, data indicated that soaking treatment significantly increased shoot length of cuttings in comparison to that of control in the two studied seasons. Soaking cuttings 24 hours showed significantly raised shoot length (22.38 and 20.42) followed by 12 hours (20.82 and 16.80). On the contrary, control had recorded the lowest shoot length (13.33and 14.23) in the two seasons respectively. With respect to effect of IBA, it showed positive effect on shoot length compared to control. IBA at 500 ppm showed significant increase in shoot length (20.45 and 18.47).followed by IBA at 1000 ppm (18.86 and 17.52), whereas control had recorded the lowest shoot length (17.23 and 15.46) in both seasons respectively.

Concerning effect of rooting media, it obvious that shoot length differed according to type of rooting media. The rooting media (sand+ peatmoss + sawdust) gave the highest shoot length (31.55 and 29.14) followed by mixture of sand and sawdust (20.45and 18.02), while the lowest shoot length was in peat moss (14.25 and 12.71) respectively, in 2014 and 2015 seasons.

Regarding the effect of interaction between soaking in water and IBA, the highest significant shoot length (24.35 and 22.14) was resulted from cuttings which soaking in water for 24 hours then treated with IBA at 500 ppm ,while the treatment of control (0 IBA + no soaking) gave the lowest shoot length (11.87and 12.57) in 2013 and 2014 seasons respectively.

As for the effect of interaction between soaking in water and rooting media, cuttings which soaking in water for 24 hours then planted in media (sand+ peatmoss + sawdust) had significantly the highest shoot length (34.78 and 32.90) respectively, in 2013 and 2014 seasons.
With respect to the effect of interaction between Indole butyric acid (IBA)and rooting media, the highest significant shoot length (34.24 and 30.82) was obtained from cuttings which treated with IBA at 500 ppm then planted in rooting media (sand+ peatmoss + sawdust) respectively, in 2013 and 2014 seasons.

With regard to effect of interaction among soaking in water, Indole butyric acid (IBA) and rooting media, cuttings treated with 500 ppm of IBA after soaking in water for 24 hours then planting in mixture of sand, peatmoss and sawdust as rooting media had significantly the highest shoot length (37.45 and 35.62), whereas the lowest shoot length (7.85 and 8.25) was attained by cuttings planting in peatmoss as a rooting media without water soaking or IBAin 2013 and 2014 seasons respectively.

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Table 10. Effects of water soaking , IBA application and rooting media on shoot length of Ramsey rootstock cuttings in 2014 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	14.81	14.11	12.91	**13.9**	18.78	17.62	16.34	**17.6**	13.05	12.28	11.06	**12.13**
Peat (A2)	13.95	11.75	11.48	**12.4**	17.66	15.86	13.57	**15.7**	11.85	10.05	8.25	**10.05**
Sawdust (A3)	12.81	15.04	11.61	**13.2**	16.64	18.39	13.20	**16.1**	11.05	12.85	8.45	**10.78**
sand + peat (A4)	15.04	15.23	12.50	**14.3**	20.32	19.39	16.58	**18.8**	12.95	13.45	10.85	**12.42**
sand+sawdust (A5)	19.84	15.91	16.37	**17.4**	23.85	20.02	20.75	**21.5**	17.45	13.65	14.33	**15.14**
sand+peat+sawdust (A6)	32.21	29.43	27.33	**29.7**	35.62	32.86	30.21	**32.9**	24.65	27.55	22.45	**24.88**
MEANS (BxC)	**18.11**	**16.91**	**15.37**		**22.14**	**20.69**	**18.44**		**15.17**	**14.97**	**12.57**	
MEANS (B)		**16.80**				**20.42**				**14.23**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	15.55	14.67	13.44	**14.55**
Peat (A2)	14.49	12.55	11.10	**12.71**
Sawdust (A3)	13.50	15.43	11.09	**13.34**
sand + peat (A4)	16.10	16.02	13.31	**15.15**
sand+sawdust (A5)	20.38	16.53	17.15	**18.02**
sand+peat+sawdust (A6)	30.82	29.94	26.66	**29.14**
MEANS (C)	**18.47**	**17.52**	**15.46**	

L.S.D 0.05 for

(A) =	11.13
(B) =	3.63
(C) =	0.95
(AxB) =	22.85
(AxC) =	19.73
(BxC) =	9.58
(AxBxC) =	27.37

Table 9. Effects of water soaking , IBA application and rooting media on shoot length of Ramsey rootstock cuttings in 2013 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	18.31	17.73	17.30	**17.8**	20.55	19.78	18.56	**19.6**	11.25	10.48	9.26	**10.3**
Peat (A2)	18.00	16.46	14.29	**16.2**	20.35	17.55	15.45	**17.8**	10.05	8.25	7.85	**8.7**
Sawdust (A3)	17.42	16.06	14.40	**16.0**	20.95	18.55	15.45	**18.3**	9.25	11.05	8.05	**9.5**
sand + peat (A4)	19.01	20.01	16.94	**18.7**	20.45	20.45	18.35	**19.8**	11.15	11.65	9.05	**10.6**
sand+sawdust (A5)	25.21	21.56	21.93	**22.9**	26.35	22.55	23.23	**24.0**	17.05	13.25	12.93	**14.4**
sand+peat+sawdust (A6)	36.13	33.33	30.72	**33.4**	37.45	34.55	32.35	**34.8**	29.15	26.25	24.05	**26.5**
MEANS (BxC)	**22.3**	**20.9**	**19.3**		**24.4**	**22.2**	**20.57**		**14.65**	**13.49**	**11.87**	
MEANS (B)		**20.82**				**22.38**				**13.33**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	16.70	16.00	15.04	**15.91**
Peat (A2)	16.13	14.09	12.53	**14.25**
Sawdust (A3)	15.87	15.22	12.63	**14.57**
sand + peat (A4)	16.87	17.37	14.78	**16.34**
sand+sawdust (A5)	22.87	19.12	19.36	**20.45**
sand+peat+sawdust (A6)	34.24	31.38	29.04	**31.55**
MEANS (C)	**20.45**	**18.86**	**17.23**	

L.S.D 0.05 for	
(A) =	11.10
(B) =	1.56
(C) =	1.59
(AxB) =	26.07
(AxC) =	21.71
(BxC) =	12.49
(AxBxC) =	29.60

Shoot diameter

Data in table (11 and 12) show that effects of different rooting media, soaking cuttings in water and (IBA) on shoot diameter for Ramsey grapevine rootstock cuttings in the two seasons.

Regarding effect of soaking treatment, data indicated that soaking treatment had significantly increased shoot diameter of cuttings in comparison to that of untreated cuttings in the two studied seasons. Soaking cuttings 24 hours showed significantly higher shoot diameter (1.91 and 1.75) followed by 12 hours (1.67 and 1.69). On the contrary, control had recorded lower shoot diameter (1.60 and 1.60) respectively, in the two seasons.

IBA treatment had positive effect of IBA on shoot diameter compared to control. IBA at 500 ppm showed significantly higher shoot diameter (1.89 and 1.84).followed by IBA at 1000 ppm (73.66 and 72.19), whereas control recorded lower shoot diameter (1.59 and 1.53) respectively, in both seasons.

Concerning effect of rooting media ,it obvious that shoot diameter differed according to kind of rooting media . The rooting media (sand+ peatmoss+ sawdust) gave the highest shoot diameter (2.26 and 2.23) followed by mixture of sand and sawdust (2.05 and 1.99),while the lowest shoot diameter was in peatmoss media (65.65and 62.13) in 2014 and 2015 seasons respectively.

Regarding the effect of interaction between soaking in water and Indole butyric acid (IBA), the highest significant shoot diameter (2.07 and 1.92) was obtained from cuttings which soaking in water for 24 hours then treated with IBA at 500 ppm ,while the treatment of control (0 IBA + no soaking) gave the lowest shoot diameter (1.49 and 1.39) in 2013 and 2014 seasons respectively.

As for the effect of interaction between soaking in water and rooting media, soaking in water for 24 hours then planting in mixture of sand, peatmoss and sawdust as rooting media had significantly the highest percentage of rooting (2.36 and 2.35) respectively, in 2013 and 2014 seasons.

With respect to the effect of interaction between IBA and rooting media, the highest significant percentage of rooting 2.36 and 2.37respectively in 2013 and 2014 seasons was resulted from cuttings which planted in mixture of sand + peatmoss + sawdust after treated with IBA at 500 ppm.

With regard to effect of interaction among soaking in water, indole butyric acid (IBA) and rooting media, cuttings treated with 500 ppm of IBA after soaking in water for 24 hours then planting in mixture of sand, peat moss and sawdust as rooting media had significantly the highest shoot diameter (2.65and 2.51), whereas the lowest shoot diameter (0.95 and 0.98) was attained by cuttings planting in peat moss as a rooting media without water soaking or IBA in 2013 and 2014 seasons respectively.

Table11. Effects of water soaking, IBA application and rooting media on shoot diameter of Ramsey rootstock cuttings in 2013 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	2.17	1.17	1.16	**1.50**	2.10	1.64	1.80	**1.84**	1.62	1.88	0.97	**1.49**
Peat (A2)	1.18	1.21	1.08	**1.16**	1.44	1.40	1.40	**1.42**	1.22	0.97	0.95	**1.05**
Sawdust (A3)	1.37	1.16	1.66	**1.39**	1.58	1.49	1.76	**1.61**	1.57	1.17	1.02	**1.25**
sand + peat (A4)	2.14	1.81	1.27	**1.74**	2.23	1.99	1.84	**2.02**	1.68	1.54	1.73	**1.65**
sand+sawdust (A5)	2.25	1.85	1.78	**1.96**	2.45	2.18	1.92	**2.18**	1.87	1.93	2.18	**1.99**
sand+peat+sawdust (A6)	2.47	2.35	2.03	**2.29**	2.65	2.44	1.98	**2.36**	1.97	2.37	2.09	**2.14**
MEANS (BxC)	**1.93**	**1.59**	**1.50**		**2.07**	**1.86**	**1.79**		**1.66**	**1.64**	**1.49**	
MEANS (B)		**1.67**				**1.91**				**1.60**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	1.96	1.56	1.31	**1.61**
Peat (A2)	1.28	1.19	1.15	**1.21**
Sawdust (A3)	1.50	1.27	1.48	**1.42**
sand + peat (A4)	2.01	1.78	1.61	**1.80**
sand+sawdust (A5)	2.19	1.99	1.96	**2.05**
sand+peat+sawdust (A6)	2.36	2.39	2.04	**2.26**
MEANS (C)	**1.89**	**1.70**	**1.59**	

L.S.D 0.05 for

(A) =	0.22
(B) =	0.23
(C) =	0.19
(AxB) =	1.31
(AxC) =	1.22
(BxC) =	0.58
(AxBxC) =	1.70

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Table 12. Effects of water soaking, IBA application and rooting media on shoot diameter of Ramsey rootstock cuttings in 2014 season.

	water soaking for 12 hours (B1)				water soaking for 24 hours (B2)				non soaking (B3)			
	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)	IBA 500 ppm (C1)	IBA 1000 ppm (C2)	IBA 0 ppm (C3)	Means (AXB)
Sand (A1)	2.01	1.50	1.02	**1.51**	1.98	1.99	1.10	**1.69**	1.76	1.68	1.20	**1.55**
Peat (A2)	1.10	1.33	1.08	**1.17**	1.35	1.02	1.15	**1.17**	1.29	1.30	0.98	**1.19**
Sawdust (A3)	1.30	1.41	1.02	**1.24**	1.50	1.25	1.08	**1.28**	1.68	1.53	1.10	**1.44**
sand + peat (A4)	1.96	1.68	1.87	**1.84**	2.10	1.65	1.86	**1.87**	1.77	1.70	1.52	**1.66**
sand+sawdust (A5)	2.06	1.73	2.24	**2.01**	2.10	2.05	2.31	**2.15**	2.02	1.76	1.65	**1.81**
sand+peat+sawdust (A6)	2.50	2.30	2.33	**2.38**	2.51	2.33	2.22	**2.35**	2.09	1.89	1.90	**1.96**
MEANS (BxC)	**1.82**	**1.66**	**1.59**		**1.92**	**1.71**	**1.62**		**1.77**	**1.64**	**1.39**	
MEANS (B)		**1.69**				**1.75**				**1.60**		

	Means (AxC)			**Means**
	C1	C2	C3	**(A)**
Sand (A1)	1.92	1.72	1.11	**1.58**
Peat (A2)	1.25	1.22	1.07	**1.18**
Sawdust (A3)	1.49	1.40	1.07	**1.32**
sand + peat (A4)	1.94	1.68	1.75	**1.79**
sand+sawdust (A5)	2.06	1.85	2.07	**1.99**
sand+peat+sawdust (A6)	2.37	2.17	2.15	**2.23**
MEANS (C)	**1.84**	**1.67**	**1.53**	

L.S.D 0.05 for

(A) =	0.24
(B) =	0.06
(C) =	0.17
(AxB) =	1.16
(AxC) =	1.30
(BxC) =	0.53
(AxBxC) =	1.53

Discussion

It is generally agreeable by the vine nursery industry that the standard practice of soaking propagation material overnight is beneficial and enhances rooting of the cuttings. The duration generally changes from some hours to longer times. This research was conducted to determine the duration of water soaking and effects with and without IBA application on the rooting of hard to root Ramsey rootstock.

In this study, overall results showed that 24 hours of soaking in water was the best for rooting. Keeping the cuttings submerged in water at least 24 hours and applying IBA afterwards resulted in the best results, Gökbayrak *et al.* (2009). Moreover, Eifert *et al.* (1970) found that immersion of vine cuttings which stimulated root and callus formation might have been the result of leaching out of growth inhibitors.

Kracke *et al.* (1981) found that hard-to-root rootstock 140Ru contained a low level of auxin and a very high amount of GA and ABA-like substances inhibiting root formation. They reported that soaking in water enhanced the rooting ability of 140Ru and raised its IAA level.

Bartolini *et al.* (1986) also stated that dipping the cuttings of 140Ru and 5BB for 12 hours reduced the quantity of GA-like substances and resulted in increased rooting ability. Later analysis of the water showed that for rootstocks, the maximum rooting capacity was associated with an increase in IAA-like and a decrease in GA-like substances.

These findings were in agreement with the reports of Chapman and Hussey (1980); Coppola and Forlani (1985) and Fabbri *et al.* (1986) who found that water dipping improved the percentage of rooted cuttings. However, Roberto *et al.* (2004) reported that 48 hours of stratification in water provided the highest percentage of rooted cuttings for Jales and the highest number of roots for Kober 5BB and Campinas rootstocks. The fresh and dry masses of roots and the percentage of cuttings with shoot growth were higher when the cuttings were submitted to the stratification treatment. Waite and May (2005) soaked Chardonnay cuttings in 0, 4 and 15 hours in water and found that only 15 hour soaking produced roots. Halbrook (1985) stated that although soaking scion cuttings in water for 12 hours ensured hydration of the plant tissues necessary for vigorous shoot growth, soaking wood of rootstocks, however, was detrimental to root production of grafted cuttings which were immediately transplanted into soil media.

According to Rongting and Pinghai (1993) scion moisture may be positively correlated with callus formation and growth ,these increases and the consequently grafting success can be explained by to their effect on grafts moisture. Its effect may be similar to those obtained by hot water treatments as soaking scion wood in water for 12 hr prior to grafting ensures hydration of the plant tissues necessary for vigorous shoot growth and also, increased total sugars soluble sugars while decreased starch and total carbohydrates in some grapevine rootstocks(Moretti, 1988 and Phillips *et al.,* 2015).

It is well known that auxin treatments induce the rooting of cuttings of most plants. However, its effect is variable depending basically on species and some other factors like rooting media. Effects of 500 ppm IBA applications which promoted rooting%, root number, root weight, root length, shoot length and shoot diameter are also noticeable, similar to the findings obtained by Varga and Varga (1988).

In this study, results demonstrated that increasing IBA concentrations in cuttings of Ramsey rootstock had adverse influence in general, as many other researchers reported Moretti and Ridomi (1984); Coppola *et al.,* (1985); Harmail *et al.,* (1986); Borba and Kuhn (1988) and Küden *et al.* (1993) found that rooting media, and IBA applications affected rooting rates in cuttings, and the rooting percentages varied between 0-90% in their applications.

Mixture of sand, peat moss and sawdust demonstrated better results than others in all criteria. Sand as rooting media had positive effect on rooting system of cuttings. These findings are in general agreement with Çelik, (1982) who compared different rooting media.Tekintaş and Seferoglu (1998) conducted rooting trials on Ficuscarica in different media and obtained the highest rooting rate in the sand medium (71%), followed by peat moss (31%), pearlite (27%), and soil (25%) respectively.

Aeration in peat moss was poor due to its high capacity of water retention. The highly humid, rooting process is delayed as a result of oxygen deficiency (Erstad and Gislerod 1993).The best choice for rooting is a media with low capacity of water retention (Gislerodc, 1983).Low percentage of rooting in sand or sawdust only which is sufficiently aerated can be poor capacity of this media to maintain humidity and nutrition (Rahimi *et al.,* 2012).Longer roots are produced in beds with lower capacity of water retention (Ramtin *et al.,* 2010) which accords with the results obtained in this study.

Conclusion

Dipping cuttings of Ramsey in IBA at 500 ppm after soaking in water for 24 hours caused an increase in root cetrica. Sand with addition to sawdust and peatmoss are the best rooting media for root formation of Ramsey cuttings.

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