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Effect of Indole Butyric Acid Concentrations on Rooting of the Green and Hard-Wood Cuttings of Some Plum Clone Rootstocks

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The studies of rooting situations of the green and hardwood cuttings of clonal plum rootstocks such as Myrobalan GF-31, Marianna GF-8-1, Myrobalan B and Commen Mussel were carried out. For green cuttings hormone concentrations of 0, 2000, 4000 and 6000 ppm of indole butyric acid (IBA) were used whereas for hardwood cuttings hormone concentrations of 0, 1000, 2000 and 4000 ppm of IBA were used. The callusing ratio, average number of roots, average length of roots, root quality, practical cutting ratio at plant production and active cutting ratio were investigated. The highest rooting ratio was obtained as 95% in the green cuttings of Myrobalan GF-31 and 87.50% in the hardwood cuttings of Marianna GF-8-1 were found better than Myrobalan B and Commen Mussel.

Key Words: Indole butyric acid, Plum clone rootstocks, Green and hard-wood cuttings, Rooting ratio.

INTRODUCTION

In today's practice, the rootstocks used in young fruit tree production must be propagated vegatatively. The rootstocks used in pomology are mainly divided into two groups as seedling and clone rootstocks[1-3]. At all nursery managing centres of Ministry of Agriculture in Turkey are used seedlings as rootstocks to grow plum young plant[4].

The cuttages and layerings are the mainly used methods, for the multiplication of clonal rootstocks. It is necessary to have a lot of mother plants for layering method. Generally, in multiplication of clonal rootstocks, hard-wood and green cuttings are used to reduce the cost of the material, time, space and energy[3, 5, 6]. Multiplication with hard-wood cuttings is one of the easiest and cheapest methods of vegetative propagation. The green cuttings root better than the hard-wood cuttings, but they require much more care than the others[5].

The natural hormone content of cuttings has direct effect on its rooting. Essentially, a linear relation has been reported between the storage substance and the natural hormone content[7]. Because of this, the cuttings are treated with

hormones such as indole-3-butyric acid (IBA), indole-3-acetic acid (IAA) and naphthalene-acetic acid (NAA) in order to promote rooting. Yilmaz[7] and Ağaoğlu *et al.*[2] reported that the most successful results were obtained from Indolebutyric acid (IBA) in rooting of cuttings. Mendilcioğlu[8] also stated that IBA and NAA hormone applications promoted rooting and the hard-wood cuttings showed little more reaction than green cuttings in this practice[8].

Generally, perlit, sphagnum moss, sand, vermiculite, compost, volcanic tüf, torf and garden soil or combinations of these, can be used as media in rooting of cuttings. However, perlite is the most commonly used growth medium in rooting studies[9-12].

In the mist system, daytime air temperatures of 21–27°C with night temperatures of 15–20°C are satisfactory for rooting cuttings of most species[2,5].

Burak and Öz[9], Kantarci and Jacob[10], Konarli[13], and Küden and Adiyaman[14] used temperatures ranging between 19 and 22°C for rooting. Leafy cuttings are ideal for rooting under mist conditions. Transpiration is reduced to a low level but the light intensity can be high, thus promoting full photosynthetic activity; the temperature of the entire cutting is relatively low, thereby reducing the respiration rate. In tests in which leaf temperatures were recorded by thermocouples, leaves under mist were found to be 5.5 to 8.5°C cooler than leaves not under mist. In other comparisons, the air temperature in a mist bed in the greenhouse was very uniform, averaging about 21°C.

Sharma and Aier[6] applied 0, 2000, 3000 and 4000 ppm of IBA to the plum cuttings of 20–25 cm length and then the green cuttings were planted under a mist system in July and the hard-wood cuttings were planted outside in the garden conditions. At the end of this study, the highest rooting percentage was 65% (from 2000 ppm) in green cuttings, 51.4% (from 3000 ppm) in hard-wood cuttings. Reighard *et al.*[15] studied the rooting and activity of hard-wood cuttings of prunus species and varieties and found that the plum clone rootstocks treated with 2000 ppm concentration of IBA in November were active in the rates of 88% (Marianna 2624), 74% (Damas 1869) and 73% (Myrobolan B). Özkan and Madakbaş[12] also applied 0, 500 and 2000 ppm of IBA to the hard-wood cuttings of Myrobalan GF-31, Marianna GF-8-1, Myrobalan B and Commen Mussel plum clone rootstocks taken in November and determined that the best rooting was obtained with 2000 ppm of IBA. In addition, Myrobalan GF-31 (55.60%) and Marianna GF-8-1 (56.70%) clone rootstocks had better rooting rates than Myrobalan B and Commen Mussel.

The objective of this study was to determine the effect of different indole butyric acid (IBA) concentrations on the rooting rates of green and hard-wood cuttings of some plum clone rootstocks.

EXPERIMENTAL

The experiment was carried out at mist system of Horticultural Department of Gaziosmanpaşa University in 1995.

In this study were used the hard-wood and green cuttings of plum clone rootstocks such as Myrobalan GF-31, Marianna GF8-1 Myrobalan B and Commen Mussel. The cuttings of plum clones were obtained from the clonal rootstock garden of Tokat Nursery Station. The clonal plum rootstocks were pruned deeply in the pruning season of 1994–95 and then the green and hard-wood cuttings were prepared from one year old shoots. Perlite was used as rooting medium. Zero, 2000, 4000 and 6000 ppm of IBA for green cuttings, and 0, 1000, 2000 and 4000 ppm of IBA for hard-wood cuttings were applied to stimulate rooting. The IBA concentrations used on this experiment were determined as reported earlier[6].

The experimental layout was a random parcel design with three repetitions of 10 cuttings per plot (repetition). Total of 960 cuttings were used for the green and hard-wood cuttings. At least 20 cm long cuttings were obtained from bottom and medium shoots of clonal plum rootstocks in mid-November[6, 9, 13–16].

The leaves of bottom part of the green cuttings were taken off and the cuttings were planted at a depth of 15–16 cm into perlit medium. In the treatment with hormone, the bottom parts of about 2.0 cm were dipped in an indolebutiyric acid solution for 5 s. On the other hand, the control cuttings were dipped only into water. In the experiment of hard-wood cuttings, temperature of rooting medium was set to 18–21°C a day prior to cutting dipped and total perlit medium was irrigated. In addition, the cuttings were irrigated with a high dose of water immediately after planting and irrigation was repeated as needed.

Both cutting groups were planted at spaces of 10 × 10 cm in row. Mist system was used for green cuttings while the bottom heating system was used for hard-wood cuttings.

Weather circulation was obtained by opening the edges of the plastic tunnel to drop the inside temperature of the tunnel and to reduce the excess moisture in summer months. Hard-wood cuttings were uprooted from rooting medium after about eight weeks[10, 13, 14].

While appraising the results of this study, following observations and criterion were taken into account:

Callusing ratio (%): Calculated as percentage of the cuttings having at least 30% of callus formation on the edge surfaces of bottom part.

Rooting ratio (%): Calculated as percentage of cuttings with at least one root.

Average number of roots: The average number of roots of each cutting.

Average length of roots (mm): The lengths of the four roots occurring in different lengths in each cutting were determined with compass as mm and then the average length was calculated based on these values.

Root quality (1–5 points): By using the scale in Table-1, based on the average number of roots and the average length of roots, root quality was graded from 1–5 and the quality category of each cutting was determined according to the evaluation points given in Table-2.

TABLE-1
ROOT NUMBER AND ROOT LENGTH (mm) POINTS

Average number of roots	Points	Average length of roots	Points
1–3	1	1.0–30.0	1
4–6	2	30.1–40.0	2
7–9	3	40.1–50.0	3
10–12	4	50.1–60.0	4
13 and >	5	60.1 and >	5

TABLE-2
ROOT QUALITY CATEGORIES AND THEIR POINTS

Root quality	Points
Low	0.1–1.9
Middle	2.0–2.9
Good	3.0–4.9
Very good	5.0 and >

Usable (practical) cutting ratio at plant production (%): The cuttings having 2 and higher root quality points were counted and then the results were calculated as percentage.

Active cutting ratio (%): The callused and rooted cuttings were counted and then the results were determined as percentage. Statistical analysis of the values obtained from the above mentioned examinations was done according to Duncan's multiple comparison test.

RESULTS AND DISCUSSION

Green cuttings

Indole butyric acid solutions and rootstock varieties were found statistically different at 0.01 level in the event that whole criteria were taken into account (Tables 3 and 4).The highest (60.83%) and lowest (40.0%) callusing were obtained from control dose and 6000 ppm IBA dose, respectively. 2000 ppm (51.60%) and 4000 ppm (50.0%) doses of IBA were not found statistically different. While the highest (72.50%) callusing was obtained from Commen Mussel clone rootstock, the lowest (31.67%) callusing was determined from Myrobalan GF-31 clone (Table-4). The lowest (45.00%) average rooting was obtained from control experiment while the highest (83.33%) average rooting was obtained from 6000 ppm IBA application. 2000 ppm (66.67%) and 4000 ppm (73.33%) were found to be between this two doses (Table-3).

TABLE-3
THE EFFECT OF DIFFERENT IBA CONCENTRATIONS ON THE ROOTING PROPERTIES OF GREEN CUTTINGS

Criteria investigated	Doses of IBA as ppm				
	2000	4000	6000	Control	
Callusing ratio (%)	51.67b	50.00b	40.00c	60.83a	**
Rooting ratio (%)	66.67b	73.33ab	83.33a	45.00c	**
Average root number	6.77a	8.25a	8.44a	4.89b	**
Average root length (mm)	41.87b	49.69a	50.11a	24.15c	**
Spreading ratios of root (%)	38.33a	32.50a	5.00c	25.00b	**
Root quality (1–5 p)	2.55b	3.04a	3.01a	1.68	**
Practical cutting ratio at plant production (%)	50.00b	63.33ab	70.00a	25.83c	**
The active cutting ratio	98.33a	99.17a	100.00a	94.17b	**

** Values with different letters are statistically significant at the 1% probability level according to Duncan's multiple range test.

These results have shown that the highest rooting ratio was obtained from the 6000 ppm IBA treatment. In some similar studies, the highest average rooting ratios were obtained from 2000 ppm of IBA with 65%[6]; from 4000 ppm with 67.1%[13]; from 2500 ppm with 75.2%[8].

While Myrobalan GF-31 and Marianna GF8-1 gave the highest rooting ratio within 95 and 92.5%, respectively, Commen Mussel and Myrobalan B had the lowest rooting ratio, 40 and 40.83%, respectively, as shown in Table-4. Thus, Myrobalan GF-31 and Marianna GF-8-1 clone rootstocks had rooted better than Myrobalan B and Commen Mussel. In a similar study, Yapici[11] reported that the rooting ratio of green cuttings of Myrobalan GF-31 ranged between 61.1 and 94.7%[11].

The highest (8.44) and lowest (4.89) average root number were obtained from 6000 ppm and control treatment among IBA doses, respectively (Table-3). In similar studies done with plum green cuttings, the highest average root number values were obtained from 2000 ppm of IBA with 24.8[6]; from 3000 ppm with 9.5[13]; from 2500 ppm with 22.75[8].

Marianna GF 8-1 green cuttings gave the highest average root number with 10.46 and the rootstocks were found in the same statistical group with Myrobalan GF-31 (9.78 number). Commen Mussel's green cuttings had the lowest root number with 3.83 and it was found in the same statistical group with Myrobalan B (4.28) as shown Table-4. Therefore, Myrobalan GF-31 and Marianna GF-8-1 clone green cuttings formed much more root numbers than Myrobalan B and Commen Mussel.

Average root length was the highest for cutting rooted with 4000 and 6000

ppm IBA but was the lowest for the control cuttings. Besides Sharma and Aier[6], Mendilcioğlu[17] obtained the highest root length values from 2000 and 2500 ppm, respectively. On the other hand, Marianna GF-8-1 and Myrobalan GF-31's green cuttings gave higher root length with 49.9 and 49.5 mm, respectively than Myrobalan B and Commen Mussel green cuttings (Table-4).

TABLE-4
THE EFFECT OF DIFFERENT ROOTSTOCKS ON THE ROOTING PROPERTIES OF GREEN CUTTINGS

Criteria investigated	Rootstock varieties				
	My. GF-31	Ma. GF-8-1	My. B	Com. Mus.	
Callusing ratio (%)	31.67c	35.00c	63.33b	72.50a	**
Rooting ratio (%)	95.00a	92.50a	40.83b	40.00b	**
The average root number	9.78a	10.46a	4.28b	3.83b	**
The average root length (mm)	49.55a	49.96a	33.13b	33.18b	**
Spreading ratios of root (%)	40.83b	47.50a	9.17c	3.33c	**
Root quality (1–5p)	3.29a	3.30a	1.96b	1.73b	**
Practical cutting ratio at plant production (%)	84.17a	83.33a	26.67b	15.00b	**
The active cutting ratio	100.00a	100.00a	92.50b	99.17a	**

** Values with different letters are statistically significant 1% probability level according to Duncan's multiple range test.

Increasing the IBA concentration from 0 to 6000 ppm resulted in increased root quality and practical cutting ratio at plant production. In addition, Marianna GF-31 and Myrobalan GF-8-1's green cuttings gave the highest root quality point and practical cutting ratio at plant production among the rootstocks tested.

While IBA doses increased the active cutting ratio compared to control experiment, different doses were not statistically different and similar results were reported earlier[6]. In addition, only Myrobalan B green cuttings gave the lowest active cutting ratio compared to all other rootstocks tested.

Hard-wood cuttings

In the experiment done with hard-wood cuttings, increasing concentrations of IBA and different rootstocks significantly affected rooting characteristics of hard-wood cuttings as shown in Tables 5 and 6.

Increasing concentrations of IBA significantly reduced the callusing ratio but increased rooting ratio of hard-wood cuttings compared to control treatment. Özkan and Madakbaş[12] obtained the highest callusing ratio (65.0%) from control test in the plum hard-wood cuttings. On the other hand, among rootstock types, Commen Mussel and Myrobalan B had the highest callusing ratios. In conclusion to the experiment that was carried out with hard-wood cuttings of plum clone rootstocks, the callusing ratio in contrast to the rooting ratio was affected negatively from high doses of IBA as shown in the green cuttings. In general,

callusing was determined low in high IBA doses and high in low IBA doses. These results offer that callusing and rooting are different events. Also, callusing is not necessary for rooting as these results show.

TABLE-5
THE EFFECT OF DIFFERENT IBA CONCENTRATIONS ON THE ROOTING PROPERTIES OF HARD-WOOD CUTTINGS

Criteria investigated	Doses of IBA as ppm				
	1000	2000	4000	Control	
Callusing ratio (%)	29.17b	31.67b	24.17b	75.83a	**
Rooting ratio (%)	83.33a	87.50a	85.83a	37.50b	**
The average root number	4.34c	6.12a	7.35a	1.55d	**
The average root length (mm)	31.09a	28.31a	26.13ab	20.15b	**
Spreading ratios of root (%)	14.17b	16.67ab	20.00a	15.00b	**
Root quality (1–5p)	1.81a	1.90a	2.06a	1.08b	**
Practical cutting ratio at plant production (%)	41.67a	48.33a	54.17a	5.00b	**
The active cutting ratio	100.00	99.17	95.83	95.83	n.s.

** Values with different letters are statistically significant 1% probability level according to Duncan's multiple range test.
n.s.: not significant

TABLE-6
THE EFFECT OF DIFFERENT ROOTSTOCKS ON THE ROOTING PROPERTIES OF HARD-WOOD CUTTINGS

Criteria investigated	Rootstock varities				
	My. GF-31	Ma. GF8-1	My. B	Com. Mus	
Callusing ratio (%)	21.67c	36.67b	49.17a	53.33a	**
Rooting ratio (%)	78.33ab	87.50	65.00bc	63.33c	**
The average root number	5.36ab	5.68	3.65c	4.67b	**
The average root length (mm)	24.08b	24.42b	26.23ab	30.96a	*
Spreading ratios of root (%)	7.50b	10.83b	25.83a	21.67a	**
Root quality (1–5p)	1.70ab	1.82a	1.52b	1.18a	**
Practical cutting ratio at plant production (%)	36.67	45.00	30.00	37.50	n.s.
The active cutting ratio	94.17b	98.22a	99.17a	99.17a	**

**, *: Values with different letters are statistically significant at the 1% and 5% probability level, respectively, according to the Duncan's multiple range test.
n.s.: not significant

In the similar investigations carried out on plum hard-wood cuttings, the highest average rooting ratios were obtained from 3000 ppm with 51.4%[6]; from 2000 ppm with 48.30%[12]; from 1250 ppm with 86.1%[14]. Besides the highest rooting ratio (with 87.50%) of Marianna GF-8-1's hard-wood cuttings, the lowest rooting was determined in Commen Mussel, Myrobalan GF-31 and Myrobalan B rootstocks (Table-6). Moreover, in trials done by Özkan and Madakbaş[12], similar results were established.

Among the IBA doses, while the highest average root number was obtained from 4000 ppm (7.35), the lowest root number was observed in control experiment (Table-5). The highest root number was obtained from Marianna GF-8-1 and Myrobalan GF-31's hard-wood cuttings and the lowest root number was found in Myrobalan B among rootstock types as shown in Table-6. Also, the similar results were determined by various workers[6, 13, 14].

The lowest concentration of IBA dose was enough to obtain highest average root length and root quality. While Commen Mussel gave the highest root length among plum rootstocks, all rootstocks but Myrobalan B had the highest root quality values.

While IBA doses increased the practical cutting ratio at plant production, noticeably compared to control experiment, there was no statistical difference among IBA doses (Table-5). In addition, practical cutting ratios at plant production were the same for all rootstocks.

Among IBA doses, active cutting ratio was not statistically significant. In similar studies done on this subject, the highest active cutting ratios were obtained from 3000 ppm[6] and from 500 ppm dose of the IBA[12]. In addition, differences among plum clone rootstock types were minor as shown in Table-6.

Conclusion

According to the above mentioned results obtained from this study, some conclusions shown below can be proposed:

1. It has been proved that Myrobalan GF-31, Marianna GF-8-1, Myrobalan B and Commen Mussel plum clone rootstocks can be successfully multiplied by means of green and hard-wood cuttings.
2. Generally, Myrobalan GF-31 and Marianna GF-8-1 clone rootstocks showed better performance than Myrobalan B and Commen Mussel.
3. Myrobalan GF-31 and Marianna GF-8-1 rootstock's green cuttings (95.0–92.50%), rooted better than Myrobalan B and Commen Mussel rootstock's hard-wood cuttings (65.0–63.3 %).
4. The green cuttings of Myrobalan GF-31, Marianna GF-8-1 and Myrobalan B rootstocks (3.29, 3.30, 1.96 point, respectively) and the hard-wood cuttings of Commen Mussel had higher root quality point.
5. For practical cutting ratio at plant production, Myrobalan GF-31 and Marianna GF-8-1's green cuttings showed better performance than Myrobalan B and Commen Mussel's hard-wood cuttings.
6. In general, 4000 ppm was found as the most fitting IBA doses for the green cuttings taken on June 15 for the criteria investigation and 1000 ppm for the hard-wood cuttings taken on November 15.

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