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Effect of Different Collection Times and Some Treatments on Rooting and Chemical Internal Constituents of Bitter Almond Hardwood Cuttings

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Abstract: This study was carried out through the two successive seasons of 1999 / 2001 and 2000/2001 in seram house at the nursery of Agriculture, Cairo University, Egypt. Bitter almond hardwood cuttings were taken from healthy trees of about 7 years old grown in a private farm located at El-Arish North Sinai. Hardwood cuttings were prepared at 15 days intervals during the period from 15 Nov. till 15 Jan. where at each date; cuttings were prepared with about 15 cm length and 8-10 mm diameter. The basal one inch of cuttings were treated with IBA solution for five seconds at 6000, 8000 and 10000 ppm during the both seasons. All IBA treatments were done with or without wounding. Treatments were arranged in a complete randomized design with four replicates (ten cuttings per each replicate) in a factorial experiment to study the effect of IBA treatment and different cutting collection dates on the rooting parameters. The obtained results showed that Bitter almond hardwood cuttings prepared during 15 Nov. till 1st Dec. treated with IBA at 8.000 or 10.000 ppm with or without wounding resulted in the highest rooting percentage and the maximum number of roots/ cuttings. No survival percentage of bitter almond hardwood cuttings were detected for the weak root development of cuttings. Results cleared a positive relationship between C/N ratio in shoots and the rooting percentage of bitter almond hardwood cuttings. In addition, a positive relationship was detected between Ind. Phen. Ratio in shoots and the rooting percentage of bitter almond hardwood cuttings.

Key words: Bitter almond, hardwood cuttings, rooting and chemical constituents.

INTRODUCTION

Stem cutting is considered the most simple and economical method of propagation. It is important, particularly in horticulture for mass production of improved material within a short time, and to perpetuate the characteristics of the parent plant[17]. Moreover, softwood cuttings generally can root easier and quicker than other cutting types. On the other hand, older woody stem cuttings are slow to root or may just drop their leaves and not root. The period in the year in which cuttings are taken can play an important role in rooting, with many species; there is an optimal period of the year for the response of cuttings to environmental conditions at the different times of the year[16].

Basal wounding is beneficial in rooting cuttings of certain species following wounding; callus production and root development frequently are heavier along the margins of the wound. Evidently, wounded tissues are stimulated in to cell division and production of root primordial this might be due to natural accumulation of auxins and carbohydrates in the wounded area[16] . The purpose of treating cutting with auxin type growth regulators is to increase the percentage of cuttings that form roots, to hasten root initiation to increase the number and quality of root produced per cutting and to increase uniformity of rooting. Moreover, IBA is probably the best material for general use, because it is generally nontoxic to plants over a wide concentration range and is effective in promoting rooting of a large number of plant species[16].

The best rooting of almond hardwood cuttings (86%) was obtained after 30 days when treated with IBA at 4000 ppm[13]. Dormant cuttings of 4 wild rootstocks (wildpeach, wild apricot, Behi (Peach X almond) and bitter almond, five clonal plum rootstocks, plum cv. Santa Rosa, apricot cv. New castle, peach cv. July Elberta and almond cv. Nonpareil, which treated with IBA at 2000, 4000 or media, rooting percentage was positively correlated with total carbohydrates, C/N ratio and total phenols[26].

MATERIALS AND METHODS

This study was carried out through two successive seasons 1999-2000 and 2000 -2001 in searan house at the nursery of Faculty of Agriculture, Cairo University,

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Giza, Egypt. During both seasons of the study, Bitter almond hardwood cuttings were taken from healthy trees of about 8 years old grown in a private farm located at El-Arish North Sinai.

Hardwood cuttings were prepared at 15 days intervals during the period from 15 Nov. till 15 Jan. at each date cuttings were prepared with about 15cm length and 8-10 mm diameter. The basal one inch of cuttings was treated with IBA solution for five seconds at 6000, 8000 and 10.000 ppm during the both seasons. All IBA treatments were done with or without wounding. Treatments were arranged in a complete randomized design with four replicates (ten cuttings per each replicate) in a factorial experiment to study the effect of two factors IBA treatments and different cutting collection dates on the rooting parameters. After two months from planting, rooting percentage and number of roots/cutting were calculated.

Chemical analysis was done in both seasons of the study as it might explain the reasons of the failure of propagating bitter almond using stem hardwood cuttings. Also chemical analysis was carried out in order to find any possible relationship between the internal chemical components and rooting ability of bitter almond cuttings at different preparation times, therefore, the following components were determined in both seasons:

- Total carbohydrates: according to Dubois *et al.,*[5]
- Total nitrogen: according to Pirie[26].
- C/N ratio (by dividing the percent of total carbohydrates by the percent of total nitrogen).
- Total indoles: according to Larsen *et al.,*[21] and modified by Selim *et al.,*[29].
- Total soluble phenols: according to A.O.A.C.[1]
- Total indoles/ phenols ratio: (by dividing the percent of total indoles by the total soluble phenols).

RESULTS AND DISCUSSION

Rooting Percentage: The effect of wounding (w.) and IBA treatments and different cutting collection times on the rooting percentage of bitter almond hardwood cuttings prepared from 15th Nov. till 15th Jan. are presented in Table (1). Results indicated that, treating bitter almond hardwood cuttings with 8.000 ppm IBA gave the highest significant rooting percentage compared with other treatments.

Regarding cuttings collecting times, it is obvious that cuttings prepared during 15th Nov. wounded and treated with 10.000 IBA resulted in the highest rooting percentage. On the other hand, rooting percentage of cuttings prepared during 15th Jan. and treated with IBA treatments took the other way around.

Similarly during the second season, it was clear that, treating cuttings with 10000 ppm IBA resulted in the highest rooting percentage followed by cutting treated with 8000 ppm IBA compared with other treatments, also, cuttings prepared during 15th Nov. and 1st Dec. scored the highest significant rooting percentage compared with other times (Table 2).

Results also revealed a significant interaction between cutting collection times and both wounding and IBA treatments itis obvious that cuttings prepared during 15th Nov. wounded and treated with 10000 ppm IBA resulted in the highest rooting percentage. Whereas, cuttings (wounded or not wounded) prepared during 15th Jan. and treated with IBA took the other way around as no significant differences occurred between hem. Generally, it could be concluded that, cuttings prepared during both 15th Nov. and 1st Dec. and treated with IBA at 8000 ppm gave the highest rooting percentage. These results are in line with previous findings of Swedan *et al.*[32,15,24,3] who found that the best rooting and survival percentage were achieved for cuttings collected on 15th Nov. and 1st Dec. of plum peach, GF 677 and plum respectively.

Furthermore, results of many investigations indicated that, IBA increased rooting percentage, number of roots/cutting, length and fresh weight of roots. The highest results were recorded in Oct. and Nov. while the lowest were obtained in Jan. and Feb. However, 4000 ppm IBA didn't significantly affect rooting and inhibited root growth of Nemaguard peach rootstock[2,7,6]. On the other hand, Rana and Chadha[26] and Saeed[27] reported that bitter almond hardwood cuttings prepared during different dates failed completely to respond to different growth regulator treatments.

Number of Adventitious Roots Cutting: The effect of wounding (W.) and IBA treatments and different cutting collection times on the average number of adventitious roots/cutting of bitter almond hardwood cuttings prepared starting from 15th Nov. till 15th Jan. are presented in Table (3). Results indicated that, IBA treatment significantly affected the number of roots/ cutting as wounded cuttings treated with IBA at 10000 ppm resulted in the maximum number of roots/ cutting followed by IBA treatment at 10000 ppm without wounding compared with other treatments.

Concerning cutting collecting times, it was clear that, cuttings prepared during 15th Nov. recorded the greatest significant number of roots/ cutting (2.45). Significant interaction was obtained between cutting collecting times and both wounding and IBA treatments. It was clear that, cuttings prepared during 15 Nov. wounded and treated with 10000 ppm IBA resulted in the maximum, number of roots / cutting on

Table 1: Effect of bitter almond hardwood cutting treatments and different cutting Collection times on the rooting percentage during the first season.

	Time of cutting collection					
Treatments	15th Nov.	1st Dec.	15th Dec.	1st Jan.	15th Jan.	Means
Cont.	0.00 d	0.00 d	0.00 d	0.00 d	0.00 d	0.00 E
W.	0.00 d	3.33cd	3.33cd	0.00 d	3.33cd	1.99D
IBA 6000 ppm.	3.33cd	6.66bc	6.66bc	3.33cd	0.00 d	3.99BCD
IBA 8000	10.00b	15.00a	6.66bc	6.66bc	0.00 d	7.66A
IBA 10000	12.00b	0.00 d	6.66bc	0.00 d	0.00 d	3.73CD
W. IBA 6000	10.00b	0.00 d	0.00 d	3.00cd	0.00 d	2.60CD
W. IBA 8000	10.00b	10.00b	0.00 d	1.16cd	0.00 d	4.23BC
W. IBA 10000	16.67a	0.00 d	0.00 d	4.33cd	0.00 d	6.20AB
Means	7.75A	5.62A	2.91B	2.31BC	0.41C	

Means having the same letters in a column are not significantly different at 5 % level .

Table 2: Effect of bitter almond hardwood cutting treatments and different cutting Collection times on the rooting percentage during the second season.

	Time of cutting collection					
Treatments	15th Nov.	1st Dec.	15th Dec.	1st Jan.	15th Jan.	Means
Cont.	0.00 d	0.00 d	0.00 d	0.00 d	0.00 d	0.00 EF
W.	0.00 d	0.00 d	0.00 d	0.00 d	0.00 d	0.00EF
IBA 6000 ppm.	11.06abc	6.98abc	11.26abc	6.66bcd	0.00 d	7.19ABC
IBA 8000	13.33ab	16.67a	10.00abc	0.00d	0.00 d	8.00AB
IBA 10000	13.20ab	10.00abc	10.00abc	11.08abc	6.00bcd	10.05A
W. IBA 6000	10.00abc	10.00abc	0.00 d	0.00d	0.00 d	4.00CDE
W. IBA 8000	10.00abc	6.66bcd	0.00 d	0.00d	0.00 d	3.33DE
W. IBA 10000	18.00a	3.33 cd	0.00 d	3.93cd	6.00bcd	6.25ABCD
Means	9.44A	6.70A	3.90B	2.70B	1.50B	

Means having the same letters in a column are not significantly different at 5 % level.

Table 3: Effect of bitter almond hardwood cutting treatments and different cutting collection times on the number of roots/cutting during the first season .

	Time of cutting collection					
Treatments	15th Nov.	1st Dec.	15th Dec.	1st Jan.	15th Jan.	Means
Cont.	0.00 c	0.00 c	0.00 c	0.00 c	0.00 c	0.00 c
W.	0.00 c	0.66 c	0.66 c	0.00 c	0.66 c	0.39c
IBA 6000 ppm.	1.66c	1.33c	2.33c	0.33c	0.00 c	1.13BC
IBA 8000	2.33c	7.66a	1.66c	1.33c	0.00 c	2.59ABC
IBA 10000	2.33c	0.00c	7.66a	0.00c	0.00c	1.99AB
W. IBA 6000	2.33c	0.00c	0.00 c	0.66c	0.00 c	0.59BC
W. IBA 8000	2.33c	2.33c	0.00 c	1.30c	0.00 c	1.19BC
W. IBA 10000	8.66a	2.33 c	0.00 c	3.33bc	0.00c	2.86A
Means	2.45A	1.78AB	1.53AB	0.86BC	0.08C	

Means having the same letters in a column are not significantly different at 5 % level .

the other hand number of roots/cutting decreased sharply for cutting prepared during 15 Jan. whereas, no significant difference obtained with IBA treatments.

As for the second season, results revealed that, cuttings treated with IBA treatments at 10000 ppm without wounding had significantly greater average number of roots per cutting compared with other treatments (Table 4). Moreover, cuttings prepared during 15th Nov. resulted in the maxim number of roots cutting (5.74). Significant interaction was obtained between cutting collecting times and both wounding and IBA treatments as cuttings prepared during 15th Nov. and treated with either 8000 or 10000ppm IBA with or without wounding scored the greatest number of roots/cutting (10.0) and (8.33). Meanwhile, no significant differences were obtained between IBA treatments for cuttings repared during 15th Jan. in terms of number of roots/ cutting.

It can be concluded that cuttings prepared during 15 Nov. and treated with IBA at 10000 ppm with or without wounding resulted in the maximum number of roots/ cutting. These results are in agreement with Swedan *et al.*[32,15,24,] where they reported that hard wood cuttings of plum and peach and GF677 collected during Nov. and treated with 1000 or 3000 ppm IBA gave the highest rooting percentage.

Moreover, the highest results of rooting percentage, number of roots/ cutting, length and fresh weight of roots were recorded in Oct. and Nov. while the lowest were obtained in Jan. and Feb.[2,6,7].

Rooting Ability in Relation to Endogenous Levels of Some Chemical Compounds:

Total Carbohydrates (C), Total Nitrogen (N) and C/N Ratio: Results in Table (5) showed seasonal changes in total carbohydrates, total nitrogen and their ratio during 2000 season. It is clear that, bitter almond hardwood cuttings prepared during 15 Nov. gave the highest significant carbohydrate value followed by cuttings prepared during, Dec. and the lowest carbohydrates contents was obtained with cuttings prepared during 15 Jan. As for N content, results revealed that, cuttings prepared during 15 Jan resulted in the maximum Nitrogen value followed by cuttings prepared during 1st Jan. compared with other cutting preparation dates. Results also showed significant differences between C/N ratio during different cutting preparation times. It could be noticed that there was a positive relationship between C/N ratio and rooting percentage of bitter almond cuttings prepared during 15 Nov. as it recorded the highest rooting percentage.

As for the second season, it could be noticed that, bitter almond cuttings prepared during both 15th Nov. and 1st Dec. contained the highest significant carbohydrates value while; there were no significant differences between other cuttings preparation dates (Table 6). In addition, cuttings prepared during 15 Jan. gave also the highest significant nitrogen content whereas, the lowers content was obtained with cuttings prepared during 15th Nov. Results also illustrate a significant differences between C/N ratio during different cuttings preparation times, as cuttings prepared during 15th Nov. contained high C/N ratio recorded the highest rooting percentage. In general, it could be concluded that cuttings prepared during 15th Nov. contained high C/N ratio showed a positive trend as it recorded the highest rooting percentage. This result is in harmony with Fayek and Swedan[32] as they concluded that high rootng ability of Meet-Ghamr peach cuttings and six plum cvs. was accompanied with their high soluble sugars content. In addition El-Fakarani[9] working on Litchi and Meet-Ghamer peach varieties found that carbohydrates content had increased greatly from Nov. 5th to Dec 1st. Moreover, Swedan *et al.*[32], reported that plum cuttings collected from Nov., and Dec. had the highest rooting percentage. Also, Gill[13] found that, the highest content of various sugars of peach cuttings were associated with better rooting it resulted from mother cuttingeither taken at 1st or 15th Nov.

Total Soluble Indoles, (Ind.) Total Soluble Phenols (Phen.) And Ind. / Phen. Ratio: Results in Table (7) showed seasonal changes in total indoles, total soluble phenols and their ratio of bitter almond hardwood cuttings during 2000 season. Results indicated that, cuttings prepared during both 15th Nov. 1st Dec. had the highest significant total indoles compared with other cuttings preparation dates although there were no significant differences were obtained between other dates. Data also reveled that; 15th Jan. cuttings had the highest significant total soluble phenol on contrary to cuttings prepared during 15th Nov.

As for Ind./plen. Ratio, results showed that 15th No. cuttings had the highest total Ind./phen. ratio followed by cuttings prepared during 1st Dec., whereas cuttings prepared during Jan. took the other way around. It could noticed that there was a positive relationship between total indoles/total phenols ratio and rooting percentage as bitter almond hardwood cuttings prepared during 15th Nov. had the highest significant ind./phen. ratio. and best rooting percentage. Similar trend was observed for second season, results in Table (8) indicated that, both 15thNov. cuttings and 1st Dec had the highest significant total indoles content followed by 15th Dec. while cuttings prepared during 15th Jan. scored the least significant total indoles content.

Table 4: Effect of bitter almond hardwood cutting treatments and different cutting collection times on the number of roots/cutting during the second season.

	Time of cutting collection					
Treatments	15th Nov.	1st Dec.	15th Dec.	1st Jan.	15th Jan.	Means
Cont.	0.00 d	0.00 d	0.00 d	0.00 d	0.00 d	0.00D
W.	0.00 d	0.00 d	0.00 d	0.00 d	0.00 d	0.00D
IBA 6000 ppm.	6.66b	2.00cb	2.66cd	1.66cd	0.00 d	2.60AB
IBA 8000	10.00a	3.33c	1.66cd	0.00d	0.00d	2.99AB
IBA 10000	8.33a	2.00cd	2.33cd	1.66cd	1.66cd	3.19A
W. IBA 6000	2.66cd	2.66cd	0.00 d	0.00d	0.00 d	1.06CD
W. IBA 8000	8.33a	2.33cd	0.00 d	0.00d	0.00 d	2.13ABC
W. IBA 10000	10.00a	1.66cd	0.00 d	2.00cd	0.00cd	2.93AB
Means	5.74A	1.74B	0.83BC	0.66BC	0.33C	

Means having the same letters in a column are not significantly different at 5 % level.

Table 5: Seasonal changes in carbohydrates (C) and nitrogen (N) of bitter almond hardwood cuttings in relation to rooting percentage during first season.

Cutting collection date	TotalCarbohydrates(C) %	Total Nitrogen(N) %	C / NRatio	Rooting(R) %
15th Nov .	23.56 A	0.26 E	90.75 A	7.75 A
1st Dec .	23.44 AB	0.41 D	57.22 B	5.62 A
15th Dec	21.63 BC	0.46 C	47.12 C	2.91 B
1st Jan .	21.14 C	0.56 B	37.76 D	2.30 BC
15th Jan .	20.19 C	0.75 A	27.87 E	0.41 C

Means having the same letters in a column are not significantly different at 5 % level .

Table 6: Seasonal changes in carbohydrates (C) and nitrogen (N) of bitter almond hardwood cuttings in relation to rooting percentage during second season.

Cutting collection date	Total Carbohydrates(C) %	Total Nitrogen(N) %	C / N Ratio	Rooting (R) %
15th Nov .	24.45 A	0.27 E	89.53 A	9.44 A
1st Dec .	23.18 A	0.40 D	57.01 B	6.70 A
15th Dec	21.57 A	0.45 C	47.42 C	3.90 B
1st Jan .	20.77 B	0.57 B	36.45 D	2.70 B
15th Jan .	21.47 B	0.79 A	27.18 E	1.50 B

Means having the same letters in a column are not significantly different at 5 % level.

Table 7: Seasonal changes in total indoles (Ind.), total soluble phenols (phen.) and ind./phen. ratio of bitter almond cuttings rootstock at times of cutting preparation during first season.

Cutting collection date	Total Indoles(Ind)	Total soluble phenols(phen)	Ind / Phen Ratio	Rooting(R) %
15th Nov.	0.35 A	4.06 D	0.06 A	7.75 A
1st Dec.	0.24 A	4.73 C	0.05 B	5.62 A
15th Dec	0.13 B	5.03 C	0.02 C	2.91 B
1st Jan.	0.13 B	8.60 B	0.01 D	2.30 BC
15th Jan.	0.12 B	9.96 A	0.01 D	0.41 C

Means having the same letters in a column are not significantly different at 5 % level .

Table 8: Seasonal changes in total indoles (Ind.), total soluble phenols (phen.) and ind./phen. ratio of bitter almond cuttings rootstock at times of cutting preparation during second season.

Cutting collection date	Total Indoles(Ind)	Total soluble phenols(phen)	Ind / PhenRatio	Rooting(R) %
15th Nov .	0.25 A	4.54 D	0.05 A	9.44 A
1st Dec .	0.24 A	4.70 D	0.05 A	6.70 A
15th Dec	0.19 B	5.52 C	0.03 B	3.90 B
1st Jan .	0.14 C	7.79 B	0.01 C	2.70 B
15th Jan .	0.11 D	9.48 A	0.01 D	1.50 B

Means having the same letters in a column are not significantly different at 5 % level.

Regarding total soluble phenols, it could be noticed that cuttings prepared during 15th Jan. had the highest significant total soluble phenols followed by Jan. cuttings, whereas, 15th Nov. cuttings took the other way around.

As for ind./phen. ratio, it appeared that cuttings prepared during 15th Nov. and 1st Dec. had the greatest ratio, whereas 15th Jan. cuttings were on the contrary. However, a positive relationship was obtained between ind./phen. ratio and the rooting percentage of bitter almond cutting prepared during 15th Nov. and 1st Dec. It may be concluded that, rooting ability of bitter almond hard wood cuttings was proportional with the high shoots contents of C/N ratio as well as the higher ratio of indoles / phenols. On the other hand, the presence of phenolic compounds at low level was the most suitable for rooting of bitter almond. The results are in agreement with Fayek and swedan[12] who reported that, high rooting percentage of meet-Ghamr peach was proportioned with low conc. of phenolic compound.

Moreover, El-Bahy[8], reported that, there was a correlation between total indoles/ total phenols ratio in the base of hard wood cuttings of meet-Ghamr peach and their rooting potentiality, whereas, rooting ability of peach hardwood cuttings was increased by reducing the content of total phenols.

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