A comparative Study on the Propagation of Some Imported Peach Rootstocks by Using Hardwood Cuttings

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Received: *6/9/2018*

ABSTRACT: The present investigation was conducted during two successive seasons (2015/2016 and 2016/2017) to study the effects of hardwood cuttings collecting dates treated with indole-3-butyric acid (IBA), i.e. 0, 200 (24 h soaking) and 2000 ppm (1 min. dipping) on %rooted cuttings, average number of roots/cutting, average length of roots/cutting (cm), average root length/cutting (cm) and % survival of rooted cuttings of peach [*Prunus persica (L.) Batsch*] rootstocks viz. Cadaman, Nemaguard, Okinawa and Nemaredunder greenhouse conditions. The effect of cutting collection dates on cuttings total indoles, total phenols and total indoles/total phenols ratio, total carbohydrates, total nitrogen and C/N ratio, was also studied. The best date for collecting hardwood cuttings was the first of December since the mature shoots of the rootstocks contained the highest values of total indoles, total phenols and total carbohydrates and the lowest value of total nitrogen. The rooting potential of cuttings was positively correlated with their content of total indoles, total phenols, total indoles/total phenols ratio, total carbohydrate and C:N ratio, while had negative correlation with their content of total nitrogen.

The capacity of hardwood cuttings to develop adventitious roots varies among the rootstocks and between the IBA treatments. IBA at 2000 ppm recorded the highest values of % rooted cuttings (75.37 and 73.01%), and % survival of rooted cuttings (74.83 and 69.38%) for Cadaman, while IBA at 200ppm was more effective in % rooted cuttings (69.18 and 64.39%), av. No. of roots/cutting (16.67 and 15.17), average length of roots/cutting (57.72 and 50.57cm), av. root length/cutting (3.48 and 3.41cm) and % survival of rooted cuttings (65.84 and 63.48%) for Okinawa (as the mean of two dates during the two seasons of study respectively). Nemaguard recorded the lowest values in % Rooted cuttings and % Survival, while Nemared recorded moderate values in these respects. This study demonstrated the possibility propagation of imported peach rootstocks "Cadaman, Nemaguard, Okinawa and Nemared" locally by using hardwood cuttings to limit import from abroad and save hard currency for the country.

Keywords: peach, hardwood cutting, IBA, rooted cutting, survival.

INTRODUCTION

Peach *[Prunus persica (L.) Batsch*] is the most important stone fruit trees grown in Egypt. According to the FAO statistical data in year 2016, the total harvested area of peaches reached 20584Hectares (one feddan= 0.42ha) with total production of about 266628 tons. (FAOSTAT, 2016). Root-knot nematodes (*M. incognita* and *M. javanica*) have historically been the predominant species of root-knot nematodes. However, root-knot nematodes are a major problem and can limit expansion of peach growing in different areas in Egypt especially in sandy soil. So, most of peach orchards were grafted on Nemaguard rootstock because its root-knot nematode resistant.

The most common method to propagate peach rootstocks worldwide is by seed germination. Availability of seeds, less labor needed, and economics are the main advantages compared to vegetative propagation methods (Layne, 1987; Loreti and Morini, 2008). However, Seedling rootstocks often lack homogeneity because of outcrossing can occur in peach orchards, reaching up to 33% depending upon several biotic and abiotic conditions. This means that open-pollinated peach seed cannot be assumed to be self-pollinated if the seed orchard contains several genotypes (Miller *et al.,* 1989). Thus, like for scions, it is desirable to propagate rootstocks by a vegetative method in order to preserve the genetic characteristics of the original rootstock cultivar.

In Europe, there has already been an increasing trend to replace peach seedlings with clonal rootstocks, especially due to the advances in tissue culture and other vegetative methods (Loreti and Massai, 2002). Clonal Prunus genotypes have been tested around the world and released as rootstocks during the past six decades, but they all had to be screened first for ease of vegetative propagation (Reighard and Loreti, 2008).

Propagation from cuttings (cloning) produces a plant with the same characteristics as the parent and thus maintains desirable fruiting traits. In comparison with other types of cuttings (semi-hardwood, softwood and so on), hardwood cuttings are easy to take, handle and store which allows flexibility in the preparation of the cutting and, in general, less precision than cuttings that include actively growing tissue (Hartmann *et al.,* 2002).

The date of the cuttings collection is very important, because the phenological state of the stock plants has an influence on rooting (Loretti *et al.,* 1985). Endogenous content of sugars, sucrose, starch, indol-3-acetic acid (IAA) and abscisic acid (ABA) in peach shoots also changes during the year and can influence rooting on cuttings (El-Boray *et al.,* 1995; Tsipouridis *et a.l,* 2006).According to Howard (1987) and Szecskó *et al.* (2002), the best time for collecting plum cuttings is the fall. Although rooting percentage was increased when cuttings were collected from October to January (Eliwa, 1994; El-Boray *et al*., 1995; Loreti&Morini, 2008; Nečas *et al*., 2016).

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Auxin treatments are commonly used in plant propagation to increase rooting percentages, hasten root initiation, increase the number and quality of roots, and encourage uniformity of rooting (El-Boray *et al*., 1995; Blythe *et al.,* 2007). Moreover, Indole-3-butyric acid considered to be a well-accepted rooting auxin in cuttings, because it is nontoxic to plants over a wide concentration range and is effective in promoting rooting of a large number of plant species (Hartmann and Kester, 1990; Eliwa, 1994; El-Boray *et al.,* 1995; Biasi *et al*., 2000; Rufato *et al.,* 2000; Mayer *el al.,* 2015).

Cadaman has introduced to Egypt via El-Maghraby Company from Italy as tissue culture seedlings in 2013. Also, Egypt is importing Nemagaurd, Okinawa and Nemared seeds from USA, Italy, Spain and France via the privet sector every year which cost many million dollars yearly.

The objectives of this study were to increase the percentage of hardwood cuttings of Cadaman, Nemagaurd, Okinawa and Nemared peach rootstocks that form roots by treating their cuttings with IBA, to hasten root initiation, increase the number and quality of roots per cutting and rise the survival percentage of rooted cuttings. Also, to find the time or period when the percent of rooted cuttings is maximal.

MATERIALS AND METHODS

Plant material: The present investigation was conducted during two successive seasons (2015/2016 and 2016/2017) as a trial to propagate four imported peach (*Prunus persica (L.) Batsch)* rootstocks (Cadaman, Nemaguard, Okinawa and Nemared) by using hardwood cuttings and to find the time or period when the percent of rooted cuttings is maximal.

The mother plants of these rootstocks were 3-5 old-years and free from diseases, growing in loamy soil in the farm of Horticulture Research Institute, Agriculture Research Center (ARC), Egypt.

Experimental methods: During both seasons of study, the hardwood cuttings (18-22 cm length and 0.8-1.1 cm diameter, with normally spaced internodes having 6-7 buds) were prepared from sub-terminal part of one - year-old shoots at two dates (first of December and first of January). The basal portion of cuttings was dipped in benlate (Fungicide) at 1 g/L. then treated with one of the following treatments: -

a) Dipping in IBA at 2000 ppm for 1 min.
b) Soaking in IBA at 200 ppm for 24 hours.
c) Soaking in tap water for 24 hours (control).

The treated cuttings were placed in polyethylene bags filled with moist peat moss and stored in the refrigerator at 2-4°C for a month, then planted in plastic boxes (53 x 26 x 6.5 cm) filled with a mixture of peat moss, clean sand and vermiculite (1:1:1 v/v) treated with benlate (Fungicide) (1g/kg mixture). The plastic boxes Kept in the greenhouse, maintained bottom heat at 18-21ºC and irrigated with mist irrigation(15s/6min).

The experiment was laid out in a Split-Split-Plot Design with three replications and 30 cuttings per replication planted in one plastic box (53 x 26 x 6,5 cm). Main plots consisted of two cuttings collecting dates (1st Dec. and 1st Jan.), sup-plots consisted of the four peach rootstocks (Cadaman, Nemaguard, Okinawa and Nemared) and sub-subplots consisted of three IBA concentrations (0, 200, 2000 ppm).

Chemical determination in mature shoots at collecting dates of hardwood cuttings

A fresh sample from sub-terminal position of one-year old shoots were taken at the collecting dates (1st Dec. and 1st Jan.) of cuttings to determine total indoles and total soluble phenols. In this respect, twenty grams of fresh segments were weighted and blended for a constant time (3min) in 50 ml methyl alcohol 80%, then transferred quantitively into beakers covered with petri dishes, and immediately placed in the refrigerator for 24 hours. The same material was extracted twice using 80% methanolic solution according to Badr *et al*., (1971).

The crude extraction for each sample collected together, evaporated at 40ºC under vacuum till complete dryness, and then dissolved in 80% methanol and filtrated through watman No. 50. The filtrate was raised to 100 ml with 80% methanol and kept in dark vials in refrigerator for quantitative determinations.

Total indoles: Total indoles were estimated calorimetrically by using P. dimethylamino benzaldehyde (Ehritch reagent) at 530 nm according to Larsen *et al*. (1962). The concentration of total indoles was calculated using a stander curve of indole acetic acid as mg per g. dry weight.

Total phenols: Total phenols were determined using the Folin Dennis colorimetric method (A.0.A.C., 1970) at 730 nm. The concentration of total phenols was calculated using a standard curve of pyrogallol as mg per g. dry weight.

Total carbohydrates: Also, similar samples were dried at 70ºC and grounded to determine the total carbohydrates and total nitrogen. For total carbohydrates, 0.2 gm of dried sample was hydrolyzed with sulphuric acid, filtrated then 1 ml of 5% phenol solution and 5 ml sulphuric acid was added and calorimetrically determined using spectrophotometer at 490 nm according to Smith *et al*. (1956).

Total nitrogen:

For total nitrogen, 0.2 gm powder of dried samples was digested to determine total nitrogen by using Micro-Kjeldahl method as described by Pregl (1945).

In addition, carbohydrate / nitrogen as well as indoles / phenols ratios were calculated and recorded.

Rooting potentiality

% Rooted cuttings: After two months from planting date, rooting potentiality was subjected for different treatments by checking 15 planted cuttings per replicate, then the rooting percentage was calculated according to the following equation: -

Rooting % = (No of rooted cuttings) / (No of checked up cuttings) ×100

Average number of roots per rooted cutting: Roots directly arising from the lower parts of the cuttings were counted and average number of roots was calculated.

Average length of roots per rooted cutting: The length of individual root on each rooted cutting was measured

with the help of a thin flexible wire and a measuring scale. The average root length was calculated out and expressed in centimeters (cm).

%survival of rooted cuttings:

At the end of the growing season, at the first of December, number of survived rooted cuttings were counted, then the percentage of survival was calculated as following: -

Survival% = (No of well-established cuttings) / (No of remained cuttings) ×100

Statistical analysis:

The data were statistically analyzed as a factorial experiment in completely randomized design with three replicates by analysis of variance (ANOVA) using the statistical package software SAS (SAS Institute Inc., 2000, Cary, NC.، USA). Comparisons between means were made by using Duncan's multiple range test at 5 % significance level (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical content in mature shoots at collecting dates of hardwood cuttings

Total indoles and total phenols (mg/g DW): Data represented in Table (1) revealed that shoot peach rootstocks under this study were significantly deferred in their content of total indoles (mg/g DW) between of them and at the dates of hardwood cuttings collection during the two seasons of study. In both the years under study, maximum mean of total indoles content has been recorded in Okinawa rootstock (0.232 mg/g DW) in the first year and (0.303 mg/g DW) in the second year followed by Cadaman rootstock. Meanwhile, the minimum mean of total indoles has been recorded in Nemaguard rootstock shoots (0.048 mg/g DW) in the first year and (0.154 mg/g DW) in the second year which is significantly different from other rootstocks under study. Also, in both the dates (1st December and 1st January) under study the mean of the values were greatly significant differed. Since, the maximum mean of total indoles contents has been recorded in the first date (1st December) which recorded (0.167 and 0.261 mg/g DW) in the first and second season respectively. Whereas, the minimum values in this respect were recorded in the second date (1st January) which recorded (0.091 and 0.191 mg/g DW) in the first and second year respectively. For the interaction, the values significantly varied between the rootstocks and the dates of hardwood cuttings collections. Since, the highest value was recorded for Okinawa rootstock (0.329 and 0.315 mg/g DW) in the first date of cuttings collection (1st December) during the two seasons respectively followed by Cadaman rootstock (0.176 and 0.301mg/g DW). Meanwhile, the lowest value was recorded for Nemaguard rootstock (0.041mg/g DW) in the first date of collected cuttings during 2015/2016 season.

The same trend was noticed with the mature shoot of peach rootstocks content of total phenols (Table 1). The rootstocks under this study were significantly deferred in their content of total phenols (as mg/ g dray weight) between of them and at the dates of hardwood cuttings collection during the two seasons of study. In both two years under study, maximum mean of total phenols content has been recorded for Okinawa rootstock to the extent of (4.412 mg/g DW) in the first year and (2.545 mg/g DW) in the second year. Meanwhile, the minimum value of total phenols has been recorded for Nemared rootstock shoots to the extent of (2.632(mg/g DW) in the first year and (2.128 mg/g DW) in the second year which is significantly different from other rootstocks under study. Also, in both the dates (1st December and 1st January) under study the mean of the values was greatly significant differed. The maximum mean of total phenols contents has been recorded in the second date (1st January) which record (3.335mg/g DW) in the first year but it was lowest (2.201mg/g DW) in the second season, respectively. For the interaction, the values significantly deferred between the rootstocks and the dates of hardwood cuttings collections. The highest values were recorded for Okinawa rootstock (4.283 and 4.541 mg/g DW) in the first and second date, respectively during the first year of study followed by Cadaman rootstock. Meanwhile, the lowest value was recorded for Nemaguard rootstock (1.791 mg/g DW) in the second date of collection cuttings during the second year of study.

In regard to total indoles and total phenols ratio, it was clear from (Table 1) that the rootstocks under this study were significantly deferred between of them and at the dates of hardwood cuttings collection during the two years of study. In both the two years under study, maximum mean of total indoles/total phenols ratio has been recorded in Okinawa rootstock (0,052 and 0,119) in the first year and second year, respectively. Meanwhile, the minimum mean of total indoles/total phenols ratio has been recorded in Nemaguard rootstock (0.015 and 0.069) respectively during the two years of study. For the interaction, the values significantly deferred between the rootstocks and the dates of hardwood cuttings collections. The highest value was recorded for Cadaman rootstock (0.130 in the first date) followed by Okinawa rootstock (0.121 in the second date) during the second year of study. We have found similar results in the literature, with cuttings of cultivars with lower IAA-oxidase activity (which is mostly due to peroxidases) rooting better (Guskov *et al.,* 1988). However, evidence for the contrary also can be found (Ryugo and Breen, 1974). Many authors examined the role of phenolics in rooting (Wilson and Van Staden 1990; Hartman and Kester, 1997), often getting correlations between the amount of phenolics and the rate of rooting (Rana and Chadha, 1992; Szecskó *et al.*, 2007). Some phenolics preserve auxin from degradation by blocking the IAA-oxidase (peroxidase), on a way that peroxidases oxidize these phenolics instead, and auxin only later (Jarvis 1989).

Table (1): Total indoles, total phenols contents and total indoles / total phenols ratio in mature shoots at collecting dates of hardwood cuttings of Cadaman, Nemaguard, Okinawa and Nemared peach rootstocks during 2015/2016 and 2016/2017 seasons

Rootstocks	Total indoles (mg/g DW)			Total phenols (mg/g DW)			Total indoles /Total phenols ratio		
	1st Dec.	1st Jun.	Mean	1st Dec.	1st Jun.	Mean	1st Dec.	1st Jun.	Mean
Season of 2015/2016									
Cadaman	0.176b	0.105b	0.141b	3.013b	2.252d	2.805c	0.058b	0.047a	0.053a
Nemaguard	0.041d	0.055d	0.048d	2.923c	3.310b	3.117b	0.014d	0.017d	0.015d
Okinawa	0.329a	0.134a	0.232a	4.283a	4.541a	4.412a	0.076a	0.029b	0.052b
Nemared	0.123c	0.068c	0.096c	2.371d	3.239c	2.632d	0.052c	0.021e	0.034c
Mean	0.167A	0.091B		3.148B	3.335A		0.050A	0.029B	
Season of 2016/2017									
Cadaman	0.301b	0.240b	0.271b	2.312c	2.454a	2.388b	0.130a	0.098b	0.114b
Nemaguard	0.214c	0.093d	0.154d	2.490b	1.791d	2.141c	0.086d	0.052d	0.069d
Okinawa	0.315a	0.290a	0.303a	2.700a	2.390b	2.545a	0.117b	0.121a	0.119a
Nemared	0.214c	0.141c	0.178c	2.085d	2.170c	2.128d	0.102c	0.065c	0.084c
Mean	0.261A	0.191B		2.588A	2.201B		0.109A	0.084B	

Total carbohydrate and nitrogen contents (mg/g DW): It is clear from the data in Table (2) that mature shoots peach rootstocks under this study were significantly deferred in their content of total carbohydrate (as mg/g dry weight) between the rootstocks and at the dates of hardwood cuttings collections during the two seasons of study. Regarding to the rootstocks, maximum mean of total carbohydrate content has been recorded in Okinawa rootstock (28.86) in the second year followed by Nemared rootstock (28.66). Meanwhile, the minimum value of total carbohydrate has been recorded in Nemaguard rootstock (27.32) in the second year which is significantly different from other rootstocks under study. Also, in both the dates (1st December and 1st January) the mean of the values were significant differed. Since, the maximum mean of total carbohydrate contents has been recorded in the second date (1st January) which recorded (28.42 and 28.73) in the first and second year, respectively. Whereas, the minimum values in this respect were recorded in the first date (1st December) which recorded (28.35 and 28.00) in the first and second year respectively. For the interaction, the values significantly varied between the rootstocks and the dates of hardwood cuttings collection. Since, the highest value was recorded in Okinawa rootstock (28.86) in the two dates of cuttings collection during the second season. Meanwhile, the lowest value was recorded in Nemaguard rootstock (27.98 and 25.91) in the first date of collected cuttings during the two years of study, respectively. Also, mature shoots of peach rootstocks under this study were significantly deferred in their content of total nitrogen (as mg/ g dray weight) between of them and at the dates of hardwood cuttings collections during the two seasons of study (Table, 2). For the rootstocks, maximum mean of total nitrogen content has been recorded in Nemaguard rootstock (2.20 and 2.35) in the first and second year respectively. Meanwhile, the lowest mean of total nitrogen has been recorded in Cadaman rootstock (1.83) in the first year which is significantly different from other rootstocks under study. Also, in both the dates (1st December and 1st January) under study the mean of the values was significantly differed. Since, the maximum mean of total nitrogen contents has been recorded in the second date (1st January) which recorded (2.05 and 2.32) in the first and second season, respectively. Whereas, the minimum means in this respect were recorded in the first date (1st December) which recorded 1.93 and 2.15) in the first and second year respectively. For the interaction, the values significantly varied between the rootstocks and the dates of hardwood cuttings collection. The highest value was recorded in Nemaguard rootstock (2.43) in the second date of cuttings collection during the second season. Meanwhile, the lowest value was recorded in Okinawa rootstock (1.81) in the first date of collection cuttings during the first year of study.

It was clear from the data illustrated in (Table 2) that the rootstocks under this study were significantly deferred in this respect between of them and at the dates of hardwood cuttings collection during the two seasons of study. For the rootstocks under study, maximum mean of C/N ratio has been recorded in Okinawa rootstock (15.52 and 13.73) in the first year and second year respectively. Meanwhile, the minimum value of C/N ratio has been recorded in Nemared rootstock (13.06 and 11.63) during the two years of study respectively. For the interaction, the values significantly deferred between the rootstocks and the dates of hardwood cuttings collection. Since, the highest value was recorded in Okenawa rootstock (15.65 and 15.38) followed statistically by Cadaman rootstock (15.35 and 14.14) in the first and second date respectively during the first year of study. Similar results were reported in the literature, the date of the cuttings collection is very important, because the phenological state of the stock plants has an influence on rooting (Loretti *et al*., 1985). Endogenous content of sugars, sucrose, starch, indol-3-acetic acid (IAA) and abscisic acid (ABA) in peach shoots also changes during the year and can influence rooting on cuttings (El-Boray *et al*., 1995; Tsipouridis *et al*., 2006). Szecskó *et al*. (2007) concluded that the complex process of rooting can be influenced in direct or indirect ways by the factors under investigation. According to Howard (1987) and Szecskó *et al*. (2002),

the best time for collecting plum cuttings is the fall. While rooting percentage is increased when cuttings are collected from October to January (El-Boray *et al*., 1995; Szecskó and Hrotkó, 2004; Loreti & Morini, 2008; Nečas *et al*., 2016).

Sprouting: During both seasons of study, it was noticed that the extent and speed of the sprouting of observation was made cuttings planted under a greenhouse conditions (Table 1&2). In spite of the rootstocks to differences in their chilling units (CU) requirements, 150 CU for Okinawa rootstock to 850 CU for Nemaguard rootstock, all the rootstocks took the same duration in sprouting which extended 2-3 weeks for the two dates of cuttings collections and that is could be attributed to the cooled storage for the cuttings before planting in the refrigerator at 2-4°C for a month resulted in achieving the chilling units requirements of the rootstocks. The hardwood cutting treated with IBA took minimum duration in sprouting while it was longest for the control. These results were supported by Narayan *et al.* (2013) and Sukhjit Kaur, (2015) on peach.

Some researchers suggested that the presence of buds is essential for the formation of root initials (Hartmann *et al*., 1990). The buds produce some biochemical substances that have effect on root formation. These substances form only in active buds, but not during the endodormancy, when the rooting is minimal.

Table (2): Total carbohydrates, total nitrogen contents and C/N ratio in mature shoots at collecting dates of hardwood cuttings of Cadaman, Nemaguard, Okinawa and Nemared peach rootstocks during 2015/2016 and 2016/2017 seasons

Rootstocks	Total carbohydrate (mg/g DW)			Total nitrogen (mg/g DW)			C/N ratio		
	1st Dec.	1st Jun.	Mean	1st Dec.	1st Jun.	Mean	1st Dec.	1st Jun.	Mean
Season of 2015/2016									
Cadaman	28.22c	28.34c	28.28c	1.82c	1.84d	1.83d	15.35b	14.14b	14.75 b
Nemaguard	27.98d	28.46a	28.22d	2.15a	2.24a	2.20a	13.42d	12.69d	13.06 d
Okinawa	28.34b	28.46a	28.40b	1.81d	2.01c	1.91c	15.65a	15.38a	15.52 a
Nemared	28.86a	28.42b	28.63a	1.96b	2.11b	2.03b	14.41c	13.50c	13.96c
Mean	28.35B	28.42A		1.93B	2.05A		14.73A	13.93 B	
Season of 2016/2017									
Cadaman	28.77b	28.46c	28.61c	2.22b	2.30c	2.26b	13.02c	12.49b	12.76b
Nemaguard	25.91d	28.74b	27.32d	2.28a	2.43a	2.35a	11.37d	11.88d	11.63d
Okinawa	28.86a	28.86a	28.86a	1.98d	2.20d	2.09d	14.55a	12.91a	13.73a
Nemared	28.46c	28.86a	28.66b	2.16a	2.37b	2.26b	13.17b	12.17c	12.67c
Mean	28.00B	28.73A		2.15B	2.32A		13.03A	12.36B	

Rooting potentiality and %Survival of rooted cuttings: Data recorded on % rooted cuttings, average number of roots/cutting, average length of roots/cutting (cm), average root length/cutting (cm) and %survival of rooted cuttings from hardwood cuttings of peach rootstocks under the study as affected by cuttings collection date and different IBA treatments are presented in Tables (3 & 4).

In both seasons, mean percent rooted cuttings (Table 3&4) shows significant differences among rootstocks being maximum in Cadaman (75.37% in the first season and 73.1% in the second season) which is statistically at par with Okinawa (69.18% and 68.31% during the two seasons, respectively). Meanwhile, the minimum mean percent recorded in Nemagured (25.33% to 30.51% during the two seasons, respectively).As for the effect of collecting date on mean percent rooted cuttings (Table 3&4), data revealed significant differences between the two cuttings collecting dates under the study. Since the first date (1st December) was higher (39.30% in the first season and 37.47% in the second season) than the second date (1st January) which recorded 34.61% in the first season and 35.99%in the second season. In the first season of study (Table 3), among the treatments higher mean percent rooted cuttings was observed as 75.37% upon treatment with 2000 ppm IBA for Cadaman which is statistically at par with 69.18% under 200 ppm IBA in Okinawa. Among interactions, maximum percent rooted cuttings (84.07%) observed in Okinawa under 200 ppm IBA followed statistically (73.91%) under 2000 ppm IBA in Cadaman in the first date of cuttings collection and 76.52% under 2000 ppm IBA in Cadaman in the second date of cuttings collection followed statistically 64.78% under 200 ppm IBA in Cadaman in the second date of cuttings collection. In the second year of study (Table 4), among treatments higher mean percent rooted cuttings observed as 73.01% with 2000 ppm IBA in Cadaman which is statistically at par with 68.31% under 2000 ppm in Okenawa. Data reported herein were in agreement with several researchers whom obtained rooting in peach cuttings by applying IBA in concentrations from 500 to 2500 mg/L (Eliwa, 1994; El-Boray *et al*., 1995; Oliveira *et al*., 2003; Tsipouridis *et al*., 2003&2005).

In the control treatments mean percent rooted cuttings was observed as 7.25% in Okenawa followed statistically 5.08% by Cadaman in the first season of study and was 6.66% for Okenawa followed statistically 4.46% by Cadaman in the second season of study. However, it was 0.00% in Nemaguard and Nemared during both seasons. Such character indicating the presence of naturally hormones in this rootstock was sufficient amount for root initiation.

During this study, the rooting potential of cuttings was differed among the rootstocks and recorded a positively correlated with their content of total indoles, total phenols, total indoles/total phenols ratio carbohydrate and C:N ratio, while had negative correlation with their content of total nitrogen (Table 1&2). The phenomenon confirms the observations of Hess (1964) who obtained the highest amount of extractable root promoting co-factors in easy to root cuttings than in the difficult to root varieties of Chrysanthemum.

As for the effect of collecting date on mean average number of roots per cutting (Table 3and 4), data revealed significant differences between the two cuttings collecting dates under the study. Since the first date (1st December) was higher (11.61) in the first season and in the second (9.36) season than the second date (1s January) which recorded 9.3 in the first season and 7.64 in the second season. During the first season of study (Table 3), among the treatments higher mean average number of roots per cutting was observed as 34.17 upon treatment with 200 ppm IBA in Cadaman which is followed statistically 16.67 under 200 ppm IBA in Okinawa. Among interactions, maximum average number of roots per cutting 35.67 observed in Cadaman under 200 ppm IBA followed statistically 22.33 under 200 ppm IBA in Nemagurd in the first date of cuttings collection. In the second year of study (Table 4), among treatments average number of roots per cutting observed as 20.33 with 200 ppm IBA in Cadaman which is statistically at par with 19.67 under 2000 ppm in Nemaguard.

Concerning average length of roots/cutting (cm) and average root length/cutting (cm), took the same trend with average number of roots per cutting (Table 3&4).

Table (3): Effect of IBA treatments on % rooted cuttings, average roots number/cutting, average roots length/cutting, average root length/root and rooted cuttings survival % at two cuttings collection dates of some peach rootstocks during 2015/2016 season

Rootstock	IBA ppm	% Rooted cuttings			Av. Roots number/cutting			Av. Roots length/ cutting (cm)			Av. Root length /root (cm)			rooted cuttings Survival %		
		1st Dec.	1st Jan.	Mean	1st Dec.	1st Jan.	Mean	1st Dec.	1st Jan.	Mean	1st Dec.	1st Jan.	Mean	1st Dec.	1st Jan.	Mean
	control	5.88e	4.28h	5.08e	2.00d	3.00cd	2.50d	6.25d	10.77de	8.51de	3.31a	3.17ab	3.24ab	5.21g	4.28g	4.75h
Cadaman	200	59.25c	64.78b	62.02b	35.67a	32.67a	34.17a	82.00a	80.67a	81.33a	2.38a-d	2.66abc	2.52b-e	59.25b	63.04b	61.15bc
	2000	73.91b	76.82a	75.37a	17.00bcd	19.00b	18.00b	55.00abc	63.00ab	59.00a	3.00ab	3.21ab	3.11bc	73.91a	74.85a	74.38a
	control	0.00f	0.00i	0.00e	0.00d	0.00d	0.00ed	0.00d	0.00e	0.00e	0.00f	0.00d	0.00g	0.00h	0.00g	0.00h
Nemaguard	200	26.37d	24.28g	25.33d	10.33bcd	6.00cd	8.17bcd	14.67cd	19.17cde	16.92cde	1.32de	3.17ab	2.24def	24.71f	14.28f	19.49g
	2000	30.72d	29.04f	29.88d	22.33ab	4.00cd	13.17bc	49.30abc	12.77de	31.03cd	2.10b-e	3.20ab	2.65bcd	30.72e	22.37e	26.54f
	control	9.16e	5.33h	7.25e	1.33d	1.67cd	1.50d	3.50d	3.17e	3.33e	2.75abc	2.17bc	2.46b-f	3.83gh	3.95g	3.89h
Okinawa	200	84.07a	54.28cd	69.18a	19.00bc	14.33bc	16.67b	63.43ab	52.00abc	57.72ab	3.43a	3.53a	3.48a	77.40a	54.28c	65.84b
	2000	61.72c	57.13c	59.43b	3.00cd	4.67cd	3.83cd	4.00d	12.50de	8.25de	1.11e	2.11bc	1.61f	61.72b	53.80c	57.76cd
	control	0.00f	0.00i	0.00e	0.00d	0.00d	0.00d	0.00d	0.00e	.000e	0.00f	0.00d	0.00g	0.00h	0.00g	0.00h
Nemared	200	57.61c	45.88e	51.75c	15.00bcd	3.67cd	9.33bcd	23.00cd	6.17e	14.58cde	1.61de	1.72c	1.67ef	47.61d	45.88d	46.74e
	2000	62.94c	53.52d	58.23bc	13.67bcd	22.67ab	18.17b	26.50bcd	43.00cd	34.75bc	1.89cde	2.04bc	1.97def	52.94c	53.52c	53.23d
Mean		39.30A	34.61B	----	11.61A	9.3B	----	27.30A	25.27B	---	1.91B	2.25A	---	36.44A	32.52B	--

Table (4): Effect of IBA treatments on % rooted cuttings, average roots number/cutting, average roots length/cutting, average root length/root and rooted cuttings survival % at two cuttings collection dates of some peach rootstocks during 2016/2017 season

Rootstock	IBA ppm	% Rooted cuttings			Av. Roots number/cutting			Av. Roots length/ cutting (cm)			Av. Root length /root (cm)			rooted cuttings Survival %		
		1st Dec.	1st Jan.	Mean	1st Dec.	1st Jan.	Mean	1st Dec.	1st Jan.	Mean	1st Dec.	1st Jan.	Mean	1st Dec.	1st Jan.	Mean
	control	3.51ef	5.42e	4.46fg	1.00c	1.00d	1.00de	4.00c	3.00ef	3.50d	4.00b	3.00b	3.50bc	3.11f	5.08ff	4.10f
Cadaman	200	53.05c	61.36b	57.21c	20.00a	20.33a	20.17a	51.77a	54.60ab	53.18a	3.23b	3.00b	3.11c	53.18c	58.03bc	55.60c
	2000	71.58a	74.44a	73.01a	15.33ab	16.00ab	15.67ab	49.33a	63.17a	56.25a	3.29b	3.72b	3.50bc	67.65a	71.11a	69.38a
	control	0.00f	0.00e	0.00g	0.00c	0.00d	0.00e	0.00c	0.00f	0.00d	0.00d	0.00c	0.00d	0.00f	0.00f	0.00f
Nemaguard	200	27.41d	30.56d	28.96e	9.00bc	6.33bcd	7.67cd	26.00b	26.60d	26.30bc	3.07b	3.69b	3.38bc	26.39e	30.10e	28.25e
	2000	32.04d	28.99d	30.51e	19.67a	9.00d	14.33abc	57.27a	15.50de	36.38b	2.91b	1.72bc	2.32c	32.05d	27.99e	30.02e
	control	6.66e	6.66e	6.66f	1.67c	1.00d	1.33de	3.33c	8.83ef	6.08d	1.39cd	9.08a	5.24b	3.99f	1.89f	2.94f
Okinawa	200	68.75ab	60.04b	64.39b	17.33ab	13.00bc	15.17ab	52.40a	48.73bc	50.57a	3.05b	3.76b	3.41bc	69.02a	57.95c	63.48b
	2000	66.75ab	69.86a	68.31ab	7.00bc	7.00bcd	7.00cde	51.50a	52.67abc	52.08a	7.65a	7.10a	7.38a	61.35b	59.86b	60.61bc
	control	0.00f	0.00e	0.00g	0.00c	0.00d	0.00e	0.00c	0.00f	0.00d	0.00d	0.00c	0.00d	0.00f	0.00f	0.00f
Nemared	200	55.81c	45.55c	50.68d	11.00bc	3.33cd	7.17cde	30.47b	11.67ef	21.07c	2.69bc	3.31b	3.00c	53.77c	45.55d	49.66d
	2000	64.13b	49.02c	56.57c	10.33abc	14.67ab	12.50bc	32.60b	40.00c	36.30b	3.11b	2.99b	3.05c	60.80b	52.35c	56.57c
Mean		37.47A	35.99B	---	9.36A	7.64B	---	29.89A	27.06B	---	2.56B	3.44A	----	35.94A	34.16B	----

Data in Table (3 & 4) revealed significant differences among rootstocks and the maximum was in Cadaman (74.38% in the first season and 69.38% in the second season) which is followed statistically by Okinawa (65.84% and 63.48% during the two seasons, respectively).

As for the effect of collecting date on mean % survival of rooted cuttings (Table 3&4), data showed significant differences between the two cuttings collecting dates under the study. The first date (1st December) was higher (36.44% in the first season and 35.94% in the second season) than the second date (1s January) which recorded 32.52% in the first season and 34.16% in the second season. In the first season (Table 3), among the treatments higher mean %survival of rooted cuttings was observed as 74.38% upon treatment with 2000 ppm IBA in Cadaman which is followed statistically 65.48% under 200 ppm IBA in Okinawa.

Among interactions, maximum percent survival rooted cuttings 77.40. % observed in Okinawa under 200 ppm IBA which is statistically at par with 73.91% under 2000 ppm IBA in Cadaman in the first date of cuttings collection and 74.85% under 2000 ppm IBA in Cadaman in the second date of cuttings collection date. In the second season (Table 4), among treatments higher mean percent rooted cuttings observed as 69.38% with 2000 ppm IBA in Cadaman which is followed statistically by63.48% under 200 ppm in Okenawa.

It was clear from the above-mentioned results that the collecting date of hardwood cuttings had a strong influence on rooting ability. Such effect could be attributed to the presence and rates of both root inhibitor and promoter substances (as indicated in Tables 1 & 2) which were greatly differed among the rootstocks and by cuttings collecting date.

The obtained results were in conformity of the previous findings as reported by Jauanda *et al*. (1979), in which they compared Flordasun and Matchless cultivars of peach and concluded that Flordasun rooted better than cv. Matchless when treated with 1000 ppm IBA. Pervez *et al*. (2007) found that IBA concentrations ‹2000ppm IBA promoted early rooting, quick cell division as compared to other concentrations and hence, lengthy roots.

CONCLUSION

The results of the present investigation clearly indicated that the optimal time for collecting hardwood cuttings of peach rootstocks was the first of December. It could be recommend the use of IBA at the 200 ppm (24 h soaking) or 2000 ppm (1 min dipping) concentration and store in the refrigerator at 2-4°C for a month to increase the percentage of hardwood cuttings that form roots, hasten root initiation, increase number and quality of roots per cutting and rise the survival percentage of rooted cuttings of Cadaman, Nemagaurd, Okinawa and Nemared peach rootstocks. Propagation of such rootstocks by hardwood cuttings using IBA as rooting hormone can be a viable option and have commercially high value.

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دراسة مقارنة على إكثار بعض أصول الخوخ المستوردة باستخدام العقل الساقية الناضجة

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أجرى هذا البحث خلال موسمى 2016/2015 ، 2017/2016 لدراسة تأثير ميعاد أخذ العقل الساقية الناضجة ومعاملتها بإندول حمض البيوتريك (IBA) بتركيزات مختلفة صفر أو 200 جزء فى المليون بالنقع لمدة 24 ساعة أو الغمس لمدة دقيقة فى التركيز الأعلى 2000 جزء فى المليون وأثر ذلك على نسبة التجذير ، ومتوسط عدد الجذور ، طول الجذور سم ، متوسط طول الجذر سم، وأيضا نسبة بقاء العقل المجذرة فى أصول الخوخ (كادامان ، نيماجارد ، أوكيناوا ، نيمارد)تحت ظروف الصوبة. أيضا تم دراسة تاثير ميعاد أخذ العقل على محتوى الأفرخ الناضجة من الاندولات الكلية ، الفينولات الكلية والنسبة بينهما ،وكذلك الكربوهيدرات الكلية ، النيتروجين الكلى ، ونسبة C/N.

أثبتت الدراسة أن أفضل وقت لأخذ العقل هو الأول من ديسمبر ، حيث إحتوت الأفرع الناضجة على كميات عالية من الاندولات الكلية ، الفينولات الكلية ، الكربوهيدرات الكلية بينما قل محتواها من النيتروجين الكلى. ووجدت علاقة موجبة بين قدرة العقل على التجذير ومحتواها من الاندولات الكلية ، الفينولات الكلية ، نسبة الاندولات الى الفينولات ، الكربوهيدرات الكلية ونسبة C/N. بينما كانت العلاقة سالبة مع محتواها من النيتروجين الكلى.

كما أن قدرة العقل الساقية الناضجة على التجذير إختلفت بين الأصول وبعضعها وأيضا بمعاملات الاندول بيوترك أسد IBA. حيث سجلت معاملة الاندول بيوترك أسد بتركيز 2000 جزء فى المليون أعلى النتائج فى نسبة التجذير (75.37 ،73.01 %) ونسبة بقاء العقل المجذرة (74.83 ، 69.38 %) مع أصل الكادامان. فى حين المعاملة بالندول بيوترك أسد بتركيز 200 جزء فى المليون كانت أكثر تأثيرا فى نسبة التجذير (69.18 ، 64.39 %) ، عدد الجذور لكل عقلة (16.67 ، 15.17) ، طول الجذور لكل عقلة (57.72 ، 50.57 سم) ، ومتوسط طول الجذر (3.48 ، 3.41سم) ونسبة بقاء العقل المجذرة (65.84 ، 63.48 %) مع أصل الأوكيناوا (كمتوستطات لميعادى أخذ العقل خلال موسمى الدراسة). فى حين النيماجار سجل أقل القيم وسجل النيمارد قيم متوسطة فى هذه النواحى المدروسة.

وقد أوضحت هذه الدراسة إمكانية إكثار أصول الخوخ المستوردة (كادامان ، نيماجارد ، أوكيناوا ، نيمارد) محليا باستخدام العقل الساقية الناضجة للحد من الاستيراد من الخارج وتوفير العملة الصعبة للبلاد.