Effect of Preplanting Treatments and Root-Promoting Hormones on Rooting and Growth of Guava (*Psidium* Hard Wood -*guajava* L.) Montakab El-Sabahia CV Semi Cuttings in Dakahlia Governorate Egypt

تأثير معاملات ما قبل الزراعة و هرمونات التجذير على تجذير و نمو العقل الساقية النصف خشبية للجوافة صنف الصباحية بمحافظة الدقهلية مصر

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المستخلص :

إستخدم فى هذه الدراسة التى اجريت خلال عامى ٢٠١٦-٢٠١٧ ، ١٠ أشجار جوافة بذرية عمر ٢٢ عام صنف منتخب الصباحية مزروعة فى المزرعة البحثية بالبرامون معهد بحوث البساتين محافظة الدقهلية ،مصر. تم رش نصف عدد الأشجار المستخدمة بالإثيفون بتركيز ٦٠٠ جزء فى المليون فى شهر فبراير أخذت عقل نصف خشبية في مايو ويوليو . بعد أخذ العقل مباشرة تم نقعها جميعاً لمدة ٣ ساعات في الفحم النشط بنسبة ١٥%. صممت التجربة كقطاعات كاملة العشوائية ، بلغ عدد المعاملات 9 معاملات حيث استخدم اندول حمض البيوتريك بثلاث تركيزات ٣٠٠٠، ٤٥٠٠ ،٥٠٠٠ جزء فى المليون ،الإثيفون بتركيز ٦٠٠ جزء فى المليون و حمض البنزويك و الستريك بتركيز ١٠٠ جزء فى المليون. تم الحصول على نتائج أكثر ملاءمة في التاريخ الأول لأخذ العقل (مايو) ، ومن بين المعاملات ،المعاملة الخامسه (الإثيفون ٦٠٠ جزء فى المليون + حمض البنزويك ١٠٠ جزء فى المليون + إندول حمض البيوتريك ٤٥٠٠ جزء فى المليون) سجلت أفضل النتائج في نسبة التجذير ٧٠٪ ، عدد الجذور في العقلة ٤,٣ ، طول الجذور ٤,٣٢ سم ، وزن الجذور الطازج لكل عقلة ٣,٣٥ جم ونسبة البقاء من العقل التى تم تجذيرها ٥٠ ٪.

كلمات مفتاحيه: الخضرى، التكاثر،البقاء و الفحم النشط.

Abstract:

Ten well established mature seedling trees (22 years old) of guava cv. Montakab El-Sabahia CV., grown at the Baramoon experimental farm, horticulture research institute Dakahlia governorate, Egypt were used in present study during two seasons 2016-2017. Half of the selected trees were sprayed with Ethephon at 600 ppm applied in February of each year. The other half was left as a control without spraying. The semi-hard wood cuttings were taken in May and July. Immediately after collection, all cuttings were soaked for 3 hours in activated charcoal (AC) 15%. The experiment was laid out in complete randomized blocks design. The total number of treatments amounted to 9 treatments. IBA at 3000, 4500, 5000 ppm, Ethephon at 600ppm, Benzoic acid at 100ppm and Citric acid at 100ppm. The more favorable results were obtained in the first collecting date (May), and among the treatments, T5 (Ethephon 600ppm + Benzoic acid 100ppm + IBA 4500ppm T5) recorded the best results in percentage of rooted cuttings 70%, number of roots per cutting 4.3, length of roots 4.32 cm, root fresh weight per cutting 3.35g and survival percentage of rooted cuttings 50%.

Keywords: Vegetative, Propagation, Survival, Activated Charcoal.

Introduction

Guava (*Psidium guajava* L.) can be propagated by seeds (Zamir et al., 2003) as well as by vegetative (layering, budding, grafting and cuttings) (Chandra *et al.*, 2004). Propagation from seeds features individuals that are genetically heterogeneous (yield and quality of fruits), due to highly cross pollinated 35% (Yadava, 1996: Paull and Bittembender, 2006 and Mehmood *et al.*, 2013, 2014). Hence, seed propagation is used in the breeding programs to produce rootstock and it's not recommended in commercial orchards of high productivity (Giri *et al.*, 2004).

Vegetative propagation of guava is a very efficient method to produce true-to-type plants with short juvenile phase, because it perpetuates all characteristics of each cultivar (Singh, 2007). Propagation by cutting has been more effective in comparison with other vegetative methods in major guava producers (Davies and Hartman, 1988; Abdullah *et al.,* 2006: Kareem *et al.,* 2013 and Shahzad *et al.,* 2019).

The rooting of guava cuttings is influenced by several internal and external factors, which include: age, health, nutritional status (carbohydrate reserves and nitrogen compounds), hormonal balance (auxin and cytokinin) of the mother plant, cutting age, type of cutting, presence or not of leaves at cutting , time of taking cuttings, environment conditions temperature and humidity, rooting medium , phenolic compound oxidation and treatment of cuttings with growth regulators (Evans, 1992: Hartman and Kester, 2002 : Sardoei, 2014: Sohnika *et al.,* 2015: Abdul *et al.,* 2016 : Mitra and Pathak 2018 and Singh, 2018).

Guava has high content of phenolic compounds in branches and leaves which poses browning problem during in rooting process. It is a serious problem associated with the oxidation of phenolic substances leaches out from the basal ends of cuttings resulting in browning of the basal cuttings. Polyphenol oxidase (PPO) is a nuclear-coded copper-containing enzyme, which catalyses the oxidation of phenols and quinones (Vaughn *et al.,* 1988: Kim *et al.,* 2001), plays an important role in cell division and the development of root primordial considerably (Gonzalez *et al.,* 1991: Gaspar *et al.,* 1997) and act as catalyzes in the degradation of indole-3-butyric acid (IBA) (Vaughn *et al.,* 1988: Kim *et al.,* 2001).

Pretreatment of the cuttings with solutions of antioxidants [ascorbic acid, citric acid, Polyvinylpyrrolidone (PVP)] and

activated charcoal (AC) could solve the problem of oxidation of phenolic substances and enhance root formation (Chevre et al., 1983: Tagelsir *et al.,* 2006: Rai *et al.,* 2008 and El-Sharony *et al.,* 2018).

Results of recent investigation indicate that cutting can be an alternative method of propagating superior guava varieties (Nitin et al., 2015: Akram et al., 2017 and Shahzad *et al.,* 2019). As such, this study aimed to reach the best treatment that causes the high rooting, survival percentages and root characteristics improvements in guava semi-hard wood cuttings.

Materials and Methods

Study Area and Plant Material Collection.

Ten well established mature seedling trees (22 years old) of guava cv. Montakab El-Sabahia CV., grown at the Baramoon experimental farm, horticulture research institute Dakahlia governorate, Egypt were used in the present study during 2016 and 2017. The trees were subjected to the common horticultural management practices.

Ethephon Treatment.

Half of the selected trees were sprayed with ethephon (2-Chloroethyl Phosphonic Acid) at 600 ppm applied in February of each year. The other half was left as a control without spraying (with tap water).

The ethephon dose (600 ppm) was diluted according to the commercial recommendation for the product (240g/ L^{-1} of ethephon), which was used to determine the specific dose for treatment. The ethephon was diluted inside a backpack sprayer and applied to the canopy of the tree, at an approximate volume of 4 liter /tree.

Preparation of Cuttings.

Semi-hard wood cuttings were prepared from current years shoots of seedling trees, after a flush of growth took place

and have attained some degree of maturity. The cuttings material was collected early in the morning, and transferred immediately to the site of propagation. Length of each cutting was about 25 cm four to six leaves were retained near the top of each cutting. Leaf blade area was reduced to 50% by a vertical cut across the leaf. Soon after preparation all cuttings were inmmediately dipped for 3 hours in activated charcoal (AC) solution 15% and allowed to drian for few minutes (Tagelsir et al., 2006), then a fresh cut was made at the base of each cutting befor the treatment with IBA (3000, 4500 and 5000 ppm), Benzoic acid at 100ppm and Citric acid at 100 ppm.

Preparation of Benzoic Acid, Citric Acid and IBA Solutions.

Following the preparation of the cuttings, a hydro solution of Benzoic acid was prepared by weighing 0.1 g of Benzoic acid and dissolving it in 1000ml of distilled water. Solution of Citric acid at 100 ppm was prepared according to the previous method. A hydroalcoholic solution of indole-3-butyric acid (IBA) was prepared by weighing 3g of IBA and dissolving it in 50 mL of 96º alcohol, in a beaker. Once the IBA had completely dissolved, the volume was completed to 1000ml with distilled water, obtaining an IBA concentration of 3000 ppm. The same procedure was repeated for the remaining doses used (Hortman and Kester, 1960).

Planting of Cuttings.

Dipping duration for the basal ends of cuttings (2.5-3cm) was 2 minutes in Benzoic acid, Citric acid and IBA solutions. After dipping the basal ends of cuttings were allowed to dry, then the cuttings were planted in black polyethylene bags 30cm in diameter at a depth of 6-8cm. The bags contained a mixture of vermiculite and sand at ratio of 1:1 (v/v); the planted bags were placed on the soil surface in field condition and immediately after planting were irrigated.

Experimental Design and Treatment Details.

Experiments were carried out during 2016-2017, using two collecting dates (May and July). The experimental design in both collecting dates was complete randomized blocks design with 9 treatments; treatment was replicated two times, 10 cuttings each. The treatments consisted of IBA 3000ppm T1, IBA 4500ppm T2, IBA 5000ppm T3, Ethephon 600ppm + Benzoic acid 100ppm + IBA 3000ppm T4, Ethephon 600ppm + Benzoic acid 100ppm + IBA 4500ppm T5, Ethephon 600ppm + Benzoic acid 100ppm + IBA 5000ppm T6, Ethephon 600ppm + Citric acid 100ppm + IBA 3000ppm T7, Ethephon 600ppm + Citric acid 100ppm + IBA 4500ppm T8 and Ethephon 600ppm + Citric acid 100ppm + IBA 5000ppm T9.

2.7. Data collection and statistical analysis.

At 90 days after planting, the cuttings were assessed to determine average rooting percentage, average root number per cutting, average root length per cutting, average root fresh weight per cutting and average cuttings' survival percentage.

The data were statistically treated by analysis of variance (ANOVA) and differences between means of various treatments were determined using LSD test, using Statistix 9 program (Analytical Software, Tallahassee, FL. USA).

Results and Discussion

Experiments carried out in the field condition where relative humidity (%) and mean temperature (°C) were recorded during the period of experimentation (May to October) in 2016-2017 seasons. As, shown in Fig. 1 mean monthly temperatures varied from 23.7 °C to 30.5 °C in 2016-2017 seasons. Mean monthly relative humidity varied from 39.7 % to 57.6 % in 2016-2017 seasons.

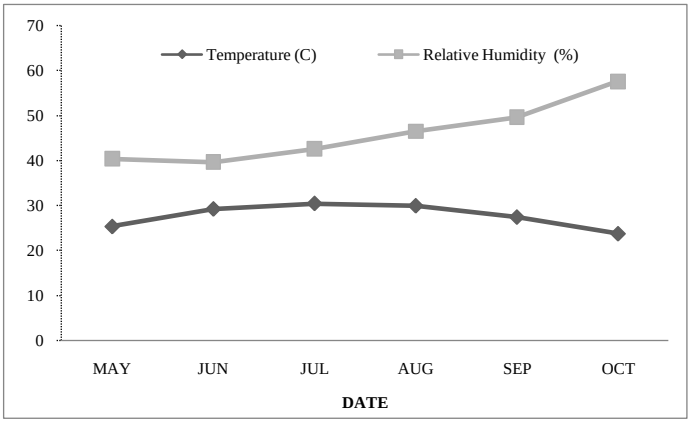

Fig. 1: Mean monthly weather data of the experiment site at Dakahlia governorate, Egypt during the period of experimentation (May - October) in 2016-2017 seasons.

Effect of Time of Taking Semi-Hard Wood Guava Cuttings on Rooting Percentage, Root Number per Cutting, Root Length per Cutting, Root Fresh Weight per Cutting and Cuttings Survival Percentage.

Time of taking cuttings (May and July) had a significant influence on rooting and survival percentage, roots number, roots length and roots fresh weight $P<0.0001$. These results are comparable with the results reported by (Sinha *et al.*, 1962: Sharma, 1975 and Rathore *et al.*, 1984).

The first collecting date (May), gave the greatest values of rooting and survival percentage, roots number, roots length and roots fresh weight in comparison with the second collecting date (July) (Table 1 and 2). The present results were in harmony with the findings of El-Iraqy, 1994 who reported that guava cuttings collected in early May gave higher rooting and survival

percentage, roots number, roots length and roots dry weigh than those collected in July or September.

Climatic condition can influence the ability of stem cuttings to grow and root. The most common factors are light, temperature, humidity, moisture level of cutting and rooting medium (Hartman *et al.*, 1997: Evans, 1992 and Singh 2018).

Table (1): Effect of the collecting date (May 2016 and 2017) of semi-hard wood guava cuttings on rooting percentage, root number per cutting, root length per cutting, root fresh weight per cutting and cuttings survival percentage.

*Cutting Treatments	Rooting percentage (%)	Number of roots	Root length (cm)	Root fresh weight (g)	Survival (%)
T1	15.0d	1.7c	2.0c	1.2c	7.0d
T2	27.0c	2.4c	2.4c	1.6c	13.0d
T3	22.0c	2.0d	2.1c	1.4c	10.0d
T4	57.0b	3.6b	3.6b	2.0bc	37.0b
T5	70.0 a	4.3 a	4.32a	3.35a	50.0a
T6	65.0b	3.8b	3.9b	2.8b	39.0b
T7	33.0bc	2.7b	2.3c	1.5c	25.0c
T8	45.0bc	3.5b	3.0bc	1.9c	34.0b
T9	40.0bc	3.0bc	2.8c	1.7c	31.0b

Ethephon 600ppm + Benzoic acid 100ppm + IBA 3000ppm T4, Ethephon 600ppm + Benzoic acid 100ppm + IBA 4500ppm T5, Ethephon 600ppm + Benzoic acid 100ppm + IBA 5000ppm T6, Ethephon 600ppm + Citric acid 100ppm + IBA 3000ppm T7, Ethephon 600ppm + Citric acid 100ppm + IBA 4500ppm T8 and Ethephon 600ppm + Citric acid 100ppm + IBA 5000ppm T9.*Within the column of each characteristic, means sharing one or more letters are insignificantly differed at 5% level according to the LSD test.

Table (2): Effect of the collecting date (July 2016 and 2017) of semi-hard wood guava cuttings on rooting percentage, root number per cutting, root length per cutting, root fresh weight per cutting and cuttings survival percentage.

*Cutting Treatments	Rooting percentage (%)	Number of roots	Root length (cm)	Root fresh weight (g)	Survival (%)
T1	10.0d	1.0c	1.5c	0.9c	3.0d
T2	21.0c	2.0c	2.0c	1.3c	9.0d
T3	16.0c	1.9d	1.8c	1.0 c	6.0d
T4	45.0b	3.0b	3.0b	1.7bc	30.0b
T5	63.0 a	4.0 a	4.0a	3.1a	44.0a
T6	55.0b	3.5b	3.2b	2.3b	37.0b
T7	22.0bc	2.3b	2.0c	1.0c	18.0c
T8	32.0bc	3.1b	2.8bc	1.7c	27.0b
T9	28.0bc	2.7bc	2.4c	1.3c	20.0b

Ethephon 600ppm + Benzoic acid 100ppm + IBA 3000ppm T4, Ethephon 600ppm + Benzoic acid 100ppm + IBA 4500ppm T5, Ethephon 600ppm + Benzoic acid 100ppm + IBA 5000ppm T6, Ethephon 600ppm + Citric acid 100ppm + IBA 3000ppm T7, Ethephon 600ppm + Citric acid 100ppm + IBA 4500ppm T8 and Ethephon 600ppm + Citric acid 100ppm + IBA 5000ppm T9.*Within the column of each characteristic, means sharing one or more letters are insignificantly differed at 5% level according to the LSD test.

Effect of Different Concentrations of IBA (3000, 4500 and 5000 ppm) on Rooting Percentage, Root Number per Cutting, Root Length per Cutting, Root Fresh Weight per Cutting and Survival Percentage in Semi-Hard Wood Guava Cuttings.

The present investigation was taken up to find out the most efficient concentrations of IBA which enhance rooting and survival percentage of cuttings and improve the rooting characters like root length, fresh weight and number.

Analysis of variance revealed that different concentrations of the IBA resulted in significant differences ($P<0.0001$) in rooting percentage, root number, root length, root fresh weight, and survival percentage in semi-hard wood guava cuttings. The highest impact was observed under the treatment of IBA at the

rate of 4500 ppm in comparison with the different concentrations of IBA 3000 and 5000ppm (Table 3 and 4). Among all the IBA concentration, IBA (4500 ppm) showed the highest results in terms of, rooting percentage (24.0), root number (2.2), root length (2.2 cm), root fresh weight (1.5 g), and survival percentage (11.0) in semi-hard wood guava cuttings, respectively (Table 3). But, treatment IBA (3000 ppm) had the lowest results in terms of, rooting percentage (12.5), root number (1.4), root length (1.8 cm), root fresh weight (1.1g), and survival percentage (5.0) in semi-hard wood guava cuttings respectively (Table 4). The results of present findings are in close conformity with the results reported by (Marco *et al.*, 1998: Bhagat *et al.*, 1999 and Rymbai and Sathyanarayana, 2010).

Table (3): Influence of different concentrations of IBA (3000, 4500 and 5000 ppm) on rooting, number of roots, root length, root fresh weight and survival in semi-hard wood guava cuttings were taken during May and July 2016 and 2017.

*Cutting Treatments	Rooting percentage (%)	Number of roots	Root length (cm)	Root fresh weight (g)	Survival (%)
T1	12.5 c	1.4 c	1.8 c	1.1 c	5.0 c
T2	24.0 a	2.2 a	2.2 a	1.5 a	11.0 a
T3	19.0 b	1.9 b	1.9 b	1.2 b	8.0 b

IBA 3000ppm T1, IBA4500ppm T2, IBA 5000ppm T3.*within the column of each characteristic, means sharing one or more letters are insignificantly differed at 5% level according to the LSD test.

Effect of the Combination of Ethephon 600ppm, Activated Charcoal (AC) 15%, Benzoic Acid 100ppm, Citric Acid 100ppm and IBA (3000, 4500 and 5000ppm) on Rooting Percentage, Root Number per Cutting, Root Length per Cutting, Root Fresh Weight per Cutting and Survival Percentage in Semi-Hard Wood Guava Cuttings.

The combination of Ethephon 600ppm, Activated Charcoal (AC) 15%, Benzoic acid 100ppm, Citric acid 100ppm and IBA (3000, 4500 and 5000ppm) showed increasing trend on rooting percentage, root number per cutting, root length per cutting, root fresh weight per cutting and survival percentage in semi-hard wood guava cuttings (table 4). These results are accordance with the finding of Prasada et al., 1988 and Marco et al., 1998. T5 (Ethephon 600ppm + Activated Charcoal (AC) 15% + Benzoic acid 100ppm + IBA 4500ppm) recorded the best values in percentage of rooted cuttings 66.5 %, number of roots per cutting 4.2, length of roots 4. 2 cm, root fresh weight per cutting 3.2g and survival percentage of rooted cuttings 47.0% (Table 4). Similar results were reported by (El-Sharony *et al.*, 2018) found that the application of IBA accompanied with antioxidant significantly increased rooting percent, root length, and number in guava.

Table (4): Influence of the combination of Ethephon 600ppm, Activated Charcoal (AC) 15%, Benzoic acid 100ppm, Citric acid 100ppm and IBA (3000, 4500 and 5000ppm on rooting, number of roots, root length, root fresh weight and survival in semi-hard wood guava cuttings were taken during May and July 2016 and 2017.

*Cutting Treatments	Rooting percentage (%)	Number of roots	Root length (cm)	Root fresh weight (g)	Survival (%)
T4	51.0 c	3.3 c	3.3 c	1.9 c	33.5 c
T5	66.5 a	4.2 a	4.2 a	3.2 a	47.0 a
T6	60.0 b	3.7 b	3.6 b	2.6 b	38.0 b
T7	27.5 f	2.5 f	2.2 f	1.3 f	21.5 f
T8	38.5 d	3.3 c	2.9 d	1.8 cd	30.5 cd
T9	34.0 e	2.9 e	2.6 e	1.5 e	25.5 e

Ethephon 600ppm + Benzoic acid 100ppm + IBA 3000ppm T4, Ethephon 600ppm + Benzoic acid 100ppm + IBA 4500ppm T5, Ethephon 600ppm + Benzoic acid 100ppm + IBA 5000ppm T6, Ethephon 600ppm + Citric acid 100ppm + IBA 3000ppm T7, Ethephon 600ppm + Citric acid 100ppm + IBA 4500ppm T8 and Ethephon 600ppm + Citric acid 100ppm + IBA 5000ppm T9.*Within the column of each characteristic, means sharing one or more letters are insignificantly differed at 5% level according to the LSD test.

Conclusion

The best time for taking semi-hard wood guava cuttings was May.

The IBA doses significantly influenced the rooting and survival percentage, root number, root length, root fresh weight in semi-hard wood guava cuttings, and the IBA treatment (4500ppm) produced the maximum values.

The combination of Ethephon 600ppm, Activated Charcoal (AC) 15%, Benzoic acid 100ppm, Citric acid 100ppm and IBA (3000, 4500 and 5000ppm) produced a significant effect in rooting and survival percentage, root number, root length, root fresh weight in semi-hard wood guava cuttings.

The treatment 5 (Ethephon 600ppm + Benzoic acid 100ppm + IBA 4500ppm) produced the maximum rooting and survival percentage, root number, root length, root fresh weight of semi-hard wood cutting, the most recommended for the propagation of guava via semi-hard wood cutting.

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