Journal of Plant Production

Journal homepage & Available online at: www.jpp.journals.ekb.eg

Influence of IBA Concentrations on the Success and Growth Characteristics of Grape Rooting Cuttings (*Vitis vinifera* L.)

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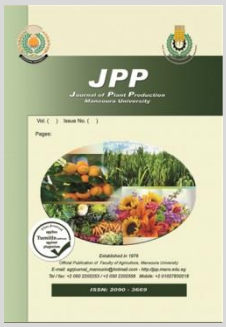

ABSTRACT

Grape is one of the most important economical fruits in the world. The propagation of grapevines is an important consideration in commercial viticulture. This study was carried out on grapes cuttings, the grape variety named (Black magic) at Al-Jabal Al-akhdar region from El – Bayda city, Libya during 2022 and 2023. The study aimed ~~at~~ to determine the effect of various concentrations of Indole-3-butyric acid (IBA), and two different dates for collecting and preparing cuttings on the rooting ability and success of grape cuttings. Three different concentrations (control water, 1000 and 2000 ppm) were applied ~~on~~ to Black magic variety (*Vitis vinifera* L.) in clay soil. After two months of planting the cuttings, the different rooting characteristics were measured such as number of roots per cutting, dry weight of the roots, and vegetative growth measurements such as percentage of successful cuttings, number of leaves per cutting, leaf area (cm^2) per cutting, and dry weight of the leaves per cutting. The results showed that the highest percentage of successful cuttings and number of the roots was achieved when using the synthetic hormone (IBA) at a concentration of 2000 ppm. These results were significantly ~~and~~ higher than those of the other treatments in terms of number of leaves, leaf area, and dry weight of the leaves for cuttings that were collected and planted in January.

Keywords: Grape, phytohormones, IBA, Libya

INTRODUCTION

Grapes are one of the most extensively cultivated in the world, that and are the most produced fruit globally. They hold great significance to the economies of many countries. The total grape area in the world is 7.5 million ha, and production reached 75.8 million tons (Tangolar, *et al*., 2019). According to the Food and Agriculture Organization (FAO), approximately 71% of world grape production is used for wine, 27% as fresh fruit, and 2% as dried fruit. Grapes were domesticated between 6,000–8,000 years ago in the region between the Black and Caspian Seas. They subsequently spread east into Asia and west into the Mediterranean region (Lu, *et al.,* 2023).

In Libya, grapes rank fourth in terms of cultivation area, following olives, citrus fruits, and date. As of 2021, the cultivated grape area in Libya reached about 8,137 hectares, with an average productivity of about 31,320 tons, according to FAO data 2021.

Success in propagation grapes trees depends on the extent of interest in the most appropriate technique, as propagation by cuttings is the best method for its their cultivation. Grapes cuttings are prepared from the previous year's growth of one-year-old wood, preferably all cuttings of the same length, 14-16 inches, and having at least 3 buds, and not more than 6 buds. Cuttings can be taken at any time during the dormant season, but in general, the best time to take cuttings in December or January (Maier, 2015).

The most important growth regulators are phytohormones, these hormones encourage, impact, and help in growth, development, and distinction of cells and tissues (Malik, *et al.,* 2023). Presently, Indole-3-butyric acid (IBA) is the most widely used plant hormone in stimulating rooting in cuttings due to its high ability to promote rooting initiation as well as its low toxicity. IBA is the most abundant natural auxin after IAA, among all the auxins, IBA is the most used hormone due to its high rooting capacity (Korasick *et al.,* 2014).

Therefore, this study aimed to determine the effect of various concentrations of Indole-3-butyric acid (IBA), and two different dates for collecting and preparing cuttings on the rooting ability and success of Black magic variety (*Vitis vinifera* L.) grape cuttings.

MATERIALS AND METHODS

The experiment site

The experiment was conducted at Al-Jabal Al-akhdar region which located in the north eastern part of Libya.

Experiment Design and Treatments

The black plastic buckets experiment was arranged in a randomized completely design (RCD) with 3 replicates for each treatment and each replicate included 15 cuttings. IBA was used at a concentration of 1000, 2000 ppm compared to the control (distilled water), and grape cuttings after being dipped in IBA for 5 seconds were grown in clay soil.

Plant material

Grape pruning residues were brought in from a private farm at Al- Jabal Al- Akhdar region, grape cuttings were taken in two different dates, the first was in January and the second was in February 2022 and 2023. When taking cuttings, it is taken into account that they are with almost length of 25-30 cm, each containing 3-4 eyes (buds). Cuttings were prepared with a straight cut directly below the

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DOI: 10.21608/jpp.2023.235068.1270

lower eye, while a tilted cut with enough distance above the upper eye. 2–3 wounds were made at the lower base of the cuttings, which were then dipped for 5 s in different concentrations of IBA pre planting.

Vegetative growth measurements

- Percentage of successful cuttings: it was estimated according to the following formula.

$$\left[\frac{Numbers\ of\ germination\ cuttings}{Numbers\ of\ all\ planted\ cuttings} * 100\right]$$

- Number of leaves per shoot: The average number of leaves per treatment was calculated 2 months of cultivation.
- Leaf area (cm^2/cutting): This estimated by average of leaves area per treatment for all cuttings and was expressed in cm^2, using a digital planimeter.
- Leaf dry weight (g/cutting): The dry weight of leaves was estimated for each cutting and the average was calculated for all cuttings for each replicate, where it was dried at 65 degrees until the weight stabilized.

Root characteristics

- Root number: Two months after planting, the average number of roots in successful seedlings was accounted**.**
- Root dry weight (g/cutting)**:** The dry weight of the roots of each cutting was estimated after oven drying at 65 degrees until the weight was stable.

Statistical analysis

Data were analyzed for one way analysis of variance, by SPSS software program (V. 20), the treatment means were compared using least significant difference ($LSD_{0.05}$) as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The cuttings rooting percentage (%)

The following figure (No. 1) shows impact of different IBA concentrations and the time, which cuttings were collected and planting on average percentage of successful cuttings (%). The results showed the positive effect of using IBA on the percentage of successful cuttings, as the results demonstrated that there were clear variations in between different concentrations of IBA. The results also show that the timing of taking and preparing cuttings led to a difference in the percentage of grape successful cuttings. The cuttings treated with 2000 ppm IBA gave the highest percentage of grape successful cuttings, regardless of whether the cuttings were collected in January or February. Where the percentage of grape successful cuttings which taken in January amounted to 88%, an increase of 10 and 3.5 % compared to the control and cuttings treated with a concentration of 1000, respectively. On the other hand, the successful percentage of cuttings of grapes collected in February reached 73%, an increase of 12.3 and 2.8% compared to the control and cuttings treated with a concentration of 1000, respectively. This may be due to the active role of IBA to increase the accumulation of the encouraging rooting materials in the cuttings, as well as its effectiveness in stimulating cell elongation and root formation (Alimam& Agha, 2021 and Brighenti, *et al*., 2023). It also increases the speed of attracting and gathering nutrients and other factors that encourage leaves growth and stimulates rooting (Garcia *et al.*, 1994 and Al-Imam& Hamid, 2019). Uddin *et al.*, (2020) also reported that auxin derived from IBA has a critical role in root and shoots development. IBA stimulate the formation of primary roots, making them less photosensitive and more chemically stable in most plants (Pires and Biasi, 2003; Brighenti *et al*., 2023). IBA increased percentage of rooting cuttings and shortens the period for rooting (Bastos *et al.*, 2009; Brighenti *et al*., 2023).

Considering the effect of the date of collecting and planting cuttings, the results show that there were clear differences between percentage of successful cuttings being planted in January than those that were prepared and planted in February, where the percentage of successful cuttings increased by 23%, 18%, and 21% in January compare with February, for three IBA treatments (0, 1000, 2000 ppm), respectively. These results are consistent with Al-Imam, Hamid (2019), they found that the dates of collected and planting the cuttings have a clear effect on the success cuttings olive. Al- Dolaemi (2012) attributed this to an increase in the percentage of carbohydrates in the cuttings, as the cuttings at the beginning of rooting rely on stored carbohydrates, or due to cuttings contain substances similar to IAA, which may differ in the time taken cuttings, which has a positive effect in increasing the rooting.

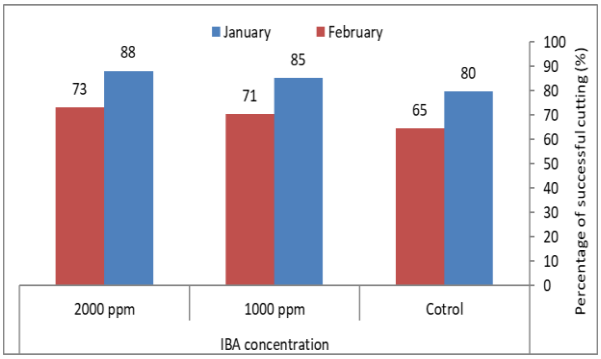

Figure 1. Effect of IBA concentrations and the time of collected and planting cuttings on percentage of successful cuttings (%)

Roots and leaves number per cutting

Data in Table 1 show that effect of IBA concentration on the average number of roots and leaves per cutting cuttings in the two dates of collection and planting.

Regarding the effect of IBA treatments, data indicated that treatments had significantly increased number of roots and leaves per cutting in comparison to that of control in the two dates collected and planting cuttings. Cuttings treated with 1000, and 2000 ppm showed significantly increased number of roots (2.9 and 6.8) and average of leaves number per cutting (2.8 and 5.8) for two IBA concentrations respectively, compare with untreated cuttings (control). As for the effect of the date of processing and planting grape cuttings, the results presented in the table (1) showed significant differences between the dates of processing and planting cuttings. We notice the superiority of the cuttings that were prepared and planted in January compared to February, as the number of roots and leaves increased by (8.2 and 4.3) respectively.

As for the effect of interaction between IBA concentrations and date of taking and planting the cuttings significantly affect had the highest number of roots and leaves (37.7 and 24.3) respectively. These were achieved when cuttings were prepared and planted in January and

treated with IBA at a concentration of 2000 ppm, where the increase in the number of roots and leaves reached 66.8% and 68.8%, respectively, compared to the control.

The increased number of roots may be due to the effect of auxin, which enhances cell division and elongation, root differentiation, and its role in mobilizing reserve nutrients to the root initiation sites, thus producing a greater number of roots per cutting (Chakraborty & Rajkumar, 2018). Thus, providing carbohydrates that supply energy and the carbon skeleton for the synthesis of organic compounds that are used to formation roots (Deepika *et al.*, 2015). The results agreed with what was reported by Stancato *et al.*, (2003) and Kaur *et al.*, (2022), who attributed the reason for the increase in the number of leaves to strong rooting, which enables the cuttings to absorb more nutrients and thus produce more leaves.

Table 1. Effect of IBA concentrations and the time of collected and planting cuttings on average number of roots and leaves per cutting

Cuttings collection dates (A)	Average number of roots per cutting				Average number of leaves per cutting			
	IBA concentrations ppm (B)				IBA concentrations ppm (B)			
	Control	1000	2000	Means (A)	Control	1000	2000	Means (A)
January	29.8 ± 7.2	33.0 ± 4	37.7 ± 3.3	33.5	18.5 ± 3.5	21.4 ± 3.6	24.3 ± 2.7	21.4
February	22.6 ± 3.4	25.1 ± 2.9	28.3 ± 2.7	25.3	14.4 ± 2.6	16.9 ± 2.1	20.1 ± 2.9	17.1
Means (B)	26.2	29.1	33.0		16.4	19.2	22.2	
$LSD_{0.05}$ (A)	1.1				0.54			
$LSD_{0.05}$ (B)	1.35				0.66			
$LSD_{0.05}$ (A*B)	2.15				1.01			

Dry weight of roots (g)

Data in Figure 2 show that effect of IBA concentration on roots dry weight per cutting for cuttings prepared and planted on two different dates.

Data shown a clear variation in the behavior of IBA concentrations on roots dry weight (Fig. 2), the data indicates that the highest value of roots dry weight (13.38 g) was obtain by grape cuttings were treated pre planting with 2000 ppm concentration and planted in January, which was significantly higher than all other treatments. On the other hand, untreated cuttings (control) had the lowest values for root dry weight in the two dates which cuttings prepared and planting (January and February) which reached (9.08 and 7.05 g).

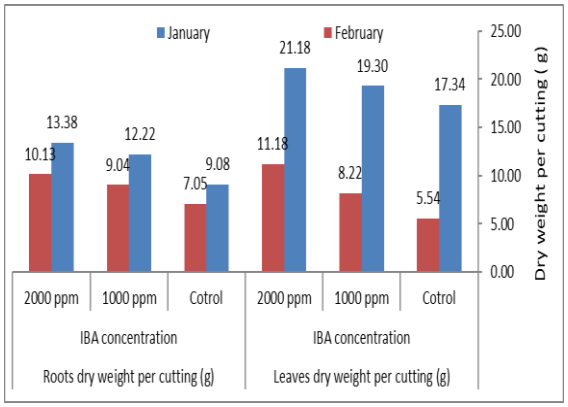

Figure 2. Effect of IBA concentrations and the time of collected and planting cuttings on average roots and leaves dry weight per cutting (g)

Dry weight of leaves (g)

It can be noticed from data presented in Figure 2 that the greatest dry weight of leaves per cutting was recorded in January for cuttings that were treated with IBA pre-planting at a concentration of 2000 ppm (21.18 g). This was significantly higher than the dry weight of cuttings from other treatments, with an increase of 20% and 9.7% compared to control and 1000 ppm, respectively. The data trend did not differ with the cuttings were prepared and planted in February, as the cuttings that were treated with IBA pre planting at a concentration of 2000 ppm, recording the best dry weight (11.18 g), with a clear variance compared with other treatments, but with a decrease of 89.5% compared to those cuttings that were prepared and planted in January at the same concentration 2000 ppm.

Leaf area (cm^2)

It is noted from the data contained in the following figure (no. 3) the clear superiority of the grape cuttings that were prepared, processed, and planted during the month of January for all treatments compared to those that were planted in the month of February, as the increase amounted to 112.4, 121.5, 129.5 for the three IBA treatments, respectively (control, 1000 ppm, and 2000 ppm). The use of IBA also increased the average of leaf area, which ranged between 479.39 cm^2 and 568.81 cm^2 for the two IBA concentrations (1000 ppm and 2000 ppm), respectively, an increase of 24.4% and 47.6%, respectively, compared to the control during the month of January. On the other hand, the average of leaf area during February ranged between 181.51cm^2 to 247.88 cm^2 for treatments, with an increase of 19.3% and 36.6 % for the two IBA concentrations (1000 ppm and 2000 ppm), respectively, compared to the control.

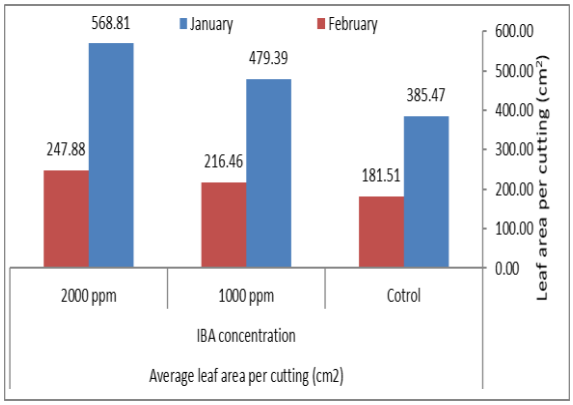

Figure 3. Effect of IBA concentrations and the time of collected and planting cuttings on average leaf area per cutting (cm^2)

Data in Figure 4 show the influence of IBA concentration on grape seedling height, where it indicates that the highest seedling length of the cuttings were treated by 2000 ppm of IBA pre planting which reached (52.73 cm), and were clearly superiority compared with others treatments. That variance was clear between two dates of cuttings prepared and planting, where cuttings prepared and planted in January performed better than in February.

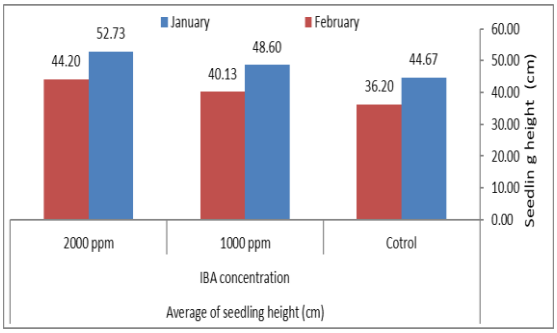

Figure 4. Effect of IBA concentrations and the time of collected and planting cuttings on average seeding height (cm)

CONCLUSION

The results of the experiment show the clear effect of the timing of taking, preparing and planting grape cuttings, as it became clear that under the conditions of Al-Jabal Al-akhdar region in Libya, it is preferable to take and prepare from one-year-old branches during January to obtain the best success rate for the cuttings. It is reflected in all characteristics vegetative and root growth.

The results of this present experiment and study also showed the positive effect of use using indolebutyric acid (IBA) as phytohormones for enhance grape cuttings rooting. Where in this study, the treatment of grape cuttings pre planting with quick dip method with concentration solution 2000 ppm IBA was found to be the most effective for greatest success of rooting and vegetative development growth.

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تأثير تركيزات IBA على نجاح تجذير عقل العنب وخصائص النمو (*Vitis vinifera* L.)

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الملخص

يعتبر العنب من أهم الفواكة الاقتصادية في العالم؛ حيث يعد انتشار كروم العنب أحد أهم الإعتبارات في زراعة العنب التجارية. أجريت هذه الدراسة على عقل العنب صنف (Black magic) بمنطقة الجبل الأخضر في مدينة البيضاء، ليبيا خلال عامي ٢٠٢٢، ٢٠٢٣. هدفت الدراسة إلى تحديد تأثير تراكيز مختلفة من حمض الإندول-٣-بيوتريك (IBA) وميعادين مختلفين لجمع وتحضير العقل علي قدرة التجذير ونجاح عقل العنب. تم تطبيق ثلاثة تراكيز مختلفة (٠، ١٠٠٠، و ٢٠٠٠ جزء في المليون) في التربة الطينية. بعد شهرين من زراعة العقل، تم قياس خصائص التجذير المختلفة مثل عدد الجذر لكل عقلة، والوزن الجاف للجذر، وقياسات النمو الخضري مثل نسبة العقل الناجحة، وعدد الأوراق لكل عقلة، ومساحة الورقة (سم٢) لكل عقلة، والوزن الجاف للأوراق لكل عقلة. أظهرت النتائج أن أعلى نسبة لنجاح العقل وعدد الجذور عند إستخدام الهرمون الصناعي (IBA) بتركيز ٢٠٠٠ جزء بالمليون. وكانت النتائج معنوية وأعلى من المعاملات الأخرى من حيث عدد الأوراق والمساحة الورقية والوزن الجاف للأوراق للعقل التي تم جمعها وزراعتها في شهر يناير.

الكلمات الدالة: العنب، الهرمونات النباتية، IBA، ليبيا