Assessment of Grape Cuttings Rooting Behavior (*Vitis Vinifera* L.) under Various Media and IBA Concentrations

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ABSTRACT: This study was conducted over two periods to collect and prepare grape (Black Magic cv.) cuttings during (2022 and 2023) to evaluate the best practices for obtaining the best grape cuttings, and seedlings, then enhancing grape production. The experiments were conducted on private farm in the Jabal Al-Akhdar area of Al-Bayda, Libya. An experiment was conducted with three concentration levels of IBA at 0 (control), 1000 ppm, and 2000 ppm, in three various rooting media (clay soil, sand + sheep manure, and Peat moss), at two different dates for grape cuttings collecting and cultivating in (January, and February). Two months later of treated and planting grape cuttings, percentage of successful cuttings, shoot length, roots number, leaves number, root dry weight, leaves dry weight, and leaf area, were measured during study period.

The obtained results, showed that the best rooting performance was obtained when grape cuttings planted in Peatmoss treated pre planting by 2000 ppm IBA, during the first date of preparation and planting cuttings (during January).

Keywords: IBA, grape cuttings, peat moss

INTRODUCTION

Viticulture is very important relevant in many countries of the world due to its large contribution to the socio and economic sectors, which occupy the first rank among fruit crops in terms of trade exchange in various forms between countries (**Ariza-Sentís *et al.,*** 2023), which area devoted to vineyards worldwide 7.3 million hectares, (**International Organization of Vine and Wine**, 2021).Where the global consumption of grapes has significantly increased over the past ten years, as the rate of increase in consumption from 2009 to 2018 was about 73%. Libya is one of the North African countries in which grapes rank fourth after citrus, olives, and dates. It comes in twelfth place among the Arab countries in terms of grape production, with the total grape production in Libya during 2018 reaching about 30 thousand tons (**FAO,** 2019).

As cuttings are good commercial practice for large-scale propagation in viticulture (**Weaver,** 1976), it should be propagated by cuttings, grafting or tissue culture (**Childers *et al.,*** 1995), so the vegetative propagation method by cuttings is the most effective method of propagation in grapes. Adventitious root formation in cuttings is the most important, that influences the success of cuttings (**Shiozaki *et al.,*** 2013).They are affected by environmental conditions and external and internal biochemical compounds. The ability of the cuttings used to root and give strong seedlings is determined by the extent of the accumulation of phenolic substances, enzymes, and the concentration of auxins in them (**Aghdaei *et al.,*** 2019).

IBA "indole-3-butyric acid" is considered one of the most important auxins used as a growth regulator and is the most widely used in promoting the root growth process in cuttings, due to its great ability to stimulate root initiation and its low toxicity (**Daskalakis *et al.,*** 2018).

The success of cultivating grape cuttings depends on the various practices with which the cuttings are prepared, such as the time for taking and preparing the cuttings, as well as the branches from which they are taken. Rooting media are also considered one of the most important factors to ensure the success of cutting growth, as these media can affect the percentage of cuttings that are rooted and their strength roots and increasing survival percentage of cuttings.

The aim of this study is to determine the best date for grape propagation, as well as the appropriate rooting soil to ensure the best growth of cuttings, in addition to the effective concentration of indole butyric acid for treating cuttings pre-planting in the Al-Jabal Al-Akhdar region in Libya

MATERIALS AND METHODS

The experiment site

The experiments were conducted at a private farm located in the north eastern part of Libya at Al-Jabal Al-akhdar region**.**

Experiment Design and Treatments

Black plastic bags were prepared and filled with three various rooting media; (clay soil, sand + sheep manure, and Peat moss), as well as three concentrations of indole butyric acid; (0, 1000, 2000 ppm) prepared for treating the cuttings pre planting, and the bags were distributed according to a completely randomized design (CRD), the potting bags were divided into 3 replications of sets of (15 bags) for each treatment. The potting bags were filled with three types of rooting media, the first type (clay soil), which consisted the field soil, the second media was a mixture of sand and sheep manure (1:1 v/v), the third type of media was only Peatmoss.

Plant material

Grape cuttings cv. (Black Magic) were taken and prepared from the residues of pruning grape trees at a private farm in the Jabal Al Akhdar region on two different dates, the first in January and the second in February during 2022 and 2023. It was taken into that cuttings were length between25-30 cm, so that each one contains on 3-4 eyes (buds). The selected grape cuttings were prepared with a straight cut just below the lower bud, while an oblique cut was made a sufficient distance above the upper bud. 2-3 cuts were made at the lower base of the cuttings before dipping them for 5 seconds in the different concentrations of IBA pre-planting them in the different media soils.

Data collection and analysis

Two months after cuttings were planted, the following measurements were recorded

Successful rooting cuttings percentage (%): The number of cuttings that produced root was recorded, and this number was expressed as percentage of total cuttings planted (**Owais,** 2010) using the formula

$$Root\ cutting\ \% = \frac{Numbers\ of\ \ cuttings\ rooted}{Total\ numbers\ of\ \ cuttings\ sprouted} \times 100$$

Number of leaves, roots per cutting: the average number of leaves, and roots in successful cuttings was accounted for each treatment in 3 replications.

Leaf area (cm^2/cutting): This estimated by average of leaves area per treatment in 3 replications, by using a digital planimeter, or by using the equation

$$Leaf\ area\ = Maximum\ leaf\ length\ (cm) \times Maximumleaf\ weidth\ (cm)\ \times 0.75$$

Leaves and roots dry weight (g/cutting): The average dry weight of leaves, and root were estimated for each cutting after dried by oven at 65 degrees until the weight stabilized.

Statistical analysis

The data was analyzed using the SPSS statistical tool (V. 20), the analysis of variance, and mean values were examined by using least significant difference (LSD $_{0.05}$) as described by **Gomez and Gomez** (1984).

RESULTS AND DISCUSSION

The effect of various concentrations of IBA, processing and planting date, on the rooting success of grape cuttings (Black Magic variety) and cutting characteristics

1- Successful cuttings (%)

The data presented in Table 1, showed that the percentage of successful cultivation of grape cuttings that were prepared and planted during the first date (January) increased compared to those planted during the second date (February), where the average of cuttings success were increased by12%. The positive effect of using indole butyric acid (IBA) is also evident, as dipping the cuttings in IBA solution at a concentration of 2000 ppm led to an increase in the success rate of the planted cuttings by 8.38%, 3.15% compared to the control (dipping in distilled water), using IBA at a concentration of 1000 ppm, respectively during the first date to prepare and cultivate the grape cuttings. On the other hand, the use of IBA at a concentration of 2000 ppm also led to an increase in the success percentage of the cuttings in the second date during February, with an increase of 12.67% and 4.72% compared to the control (distilled water) and the use of IBA at a concentration of 1000 ppm, respectively. However, this increase was insignificant compared to that which appeared in the first date during January, due to the superiority of grape cuttings planted during January.

These results agree with **Beniwal *et al.,*** 2022, they found that the greatest success percentages of grape cuttings were obtained when treated pre planting by 2000 ppm of IBA. (**Abhinav Burman *et al.,*** 2016), found that the use of IBA managed to boost the percentage of cutting which crop. Similarly results obtain by **Mehta *et al.,*** (2018) on pomegranate, where the usage IBA concentration 2000 ppm, achieved the greatest cutting percentages. This may be due to IBA works to speed the accumulation of the encouraging rooting materials in cuttings, as well as the active role and an effective in stimulating cell elongation and formation of root principles.

(**Alimam and Agha**, 2021; **Hartmann *et al.,*** 2014).

2- Shoot length (cm)

Data shown that the usage of IBA led to increase the shoot length during two dates of planting, but the grape cuttings which planted in January were better than that planted in February**.** Data shown that the usage of IBA led to increase the shoot length during two dates of planting, but the grape cuttings which planted in January were better than that planted in February. The shoot length of cuttings which treated by 2000 ppm concentration of IBA pre-planted increased by 34.98% in the first date compare to the second date, and 34.6% compared to control. As well as the cuttings which treated by 1000 ppm of IBA increased shoot length by 9.5% and 8.6% compare with control in the two planting dates, respectively, and an increase of 20.5% between the first and second planting dates. These results agree with the findings of **Alimam and Agha** (2021), they found that the highest shoot of grape cuttings were obtained when treated pre planting by 2000 ppm of IBA, while the lowest length of shoot cuttings was obtained by control treatment**.**

3- Number of roots per cutting

The IBA concentrations 2000 ppm had a maximum mean number of roots per cutting (44.62), and (32.09) in the first and second date of planting, respectively whereas the minimum mean number of roots (23.71) had noticed in control in the second date. On the other hand, the average of root number was 37.86 in the cuttings that were planted during January, an increase of 35.75% compared to the average number of roots in the cuttings that were planted during February, which averaged was 27.89.

A clear variation in the behavior of rooting the cuttings of grape indicates that the positive effects of IBA concentrations usages, which agree with the results which were obtained by **Kuar *et al.,* 2022**. This increasing of roots number were probably due to the promoted cell division, its elongation and the mobilization nutrients to root initiation sites by IBA, so gave the highest number of roots per cutting (**Chakraborty, and Rajkumar,** 2018).

4- Number of leaves per cutting

The use of IBA led to an increase in the mean number of cutting leaves planted during the two different planting dates, but it increased the mean number of leaves per cutting by 29.72% and 17.06% when using IBA at a concentration of 2000 ppm and 1000 ppm, respectively. The use of IBA at a concentration of 2000 had the highest mean number of leaves per cutting. It reached 32.78 at the first planting date, and 27.62 at the second planting date. On the other hand, the lowest mean number of leaves per cutting was in the cuttings that were not treated pre-planting with IBA (control), which amounted to 21.18.

The similar results were observed in grape (Kuar et al., 2022; Ghangale et al., 2021), jujube (Ghosh et al., 2017), citrus (Kumar et al., 2015) and in peach (Shukla et al., 2010). They reported that the usage of IBA for grape cuttings pre planting increased the number of leaves per cutting; it may due to the vigorous rooting which helps the cuttings to absorb more nutrients and thus produces more leaves (**Kuar *et al.,*** 2022; **Stancato *et al.,*** 2003).

5- Leaves dry weight (g/cutting)

The maximum mean dry weight of leaves per cutting reached (27.29 g) by cuttings which treated with 2000 ppm IBA concentration during the first date for cuttings preparation and planting (January).Where the increase reached 22.71%, and 9.29% compared to untreated cuttings, and cuttings treated by 1000 ppm IBA pre planting, respectively. Whereas the minimum mean dry weight of leaves per cutting (12.27 g) by untreated cuttings (control) during the second date of cuttings preparation and planting (February).Where the mean dry weight of leaves per cutting increased by 62.08% in those cuttings that were planted in the first date compared to those that were planted in the second date.

The similar results were obtain by **Ghangale *et al.,*** 2021on grape whose reported that the application of IBA produced more number of leaves, and increase seedlings length, which it might due to increase cell division and elongation, which led to an increase in accumulation dry matter weight in leaves. Also the similar results were reported on Pomegranate by **Seiar** in 2017, on phalsa by **Singh *et al.***, 2015, and **Rymbai et al.,** 2010 on Guava.

6- Roots dry weight (g/cutting)

Results revealed the significant effect that the treatments of IBA whether 1000 ppm or 2000 ppm improved cuttings root dry weight for both planting dates, comparison with the control (untreated cuttings). However, the cuttings that were planted in the first date in January were superior to those that were planted in February, as the mean root dry weight /cutting increased by 25.86%. Similar to the previous results obtained

with treated cuttings, the cuttings treated with 2000 ppm IBA were the best in the two planting dates, where the dry weight mean increased by 52.17%, 51.59% compared with control for both dates respectively. Also cuttings treated with 1000 ppm IBA came secondly as the best results a mean increase of 29.9%, 32.2% compared with control for both planting dates respectively. These results are agreement with the results obtained by

Aboogiala *et al.,* (2021); **Florez-Sarasa *et al.,*** (2020); **Galavi *et al.,*** (2013); and **Satisha and Adsule** (2008), they reported that usage IBA concentrations enhancing cuttings roots formation

7- Leaf area (cm^2/cutting)

Two months later after planted the mean data of leaf area per cutting were recorded, which it clear that the different concentrations of IBA had significant effect on leaf area. The maximum leaf area was recorded when used IBA 2000 ppm concentration in both planting dates, which recorded 1088.1 cm^2, and 736.11 cm^2 in the first and second date, respectively. On other hand untreated cuttings pre planting (control) recorded a minimum leaf area in both planting dates, which decreased by 33.92%, 40.65% compare with the cuttings treated by 2000 ppm concentration of IBA pre planting, where reached 719.06cm^2, and 436.86 cm^2 in the first and second date, respectively. These results are in the same trend with findings of **Kaur *et al.,*** 2022, when studied the effect of growth regulators (IBA) to enhancement success planting grape cuttings.

Table 1 The effect of various concentrations of IBA, processing and planting date, on the rooting success of grape cuttings (Black Magic variety) and seedling characteristics

IBA concentrations	Successful cuttings (%)	Seedling height (cm)	Number of roots	Number of leaves	leaves dry weight	Roots dry weight	Leaf area (cm^2)
	Av. the first date (January 2022 and 2023)						
Control (0)	82.08	47.22	31.44	25.27	22.24	11.54	719.06
1000 ppm	87.31	51.69	37.51	29.58	24.97	14.99	945.48
2000 ppm	90.46	63.56	44.62	32.78	27.29	17.56	1088.1
	86.62	54.16	37.86	29.21	24.83	14.7	917.55
	Av. the second date (February 2022 and 2023)						
Control (0)	67.64	39.51	23.71	21.18	12.27	9.13	436.86
1000 ppm	75.59	42.91	27.60	24.62	15.33	12.07	585.17
2000 ppm	80.31	47.09	32.09	27.62	18.37	13.84	736.11
	74.51	43.17	27.89	24.47	15.32	11.68	586.05

The effect of different rooting media, processing and planting date, on the rooting success of grape cuttings (Black Magic variety) and seedling characteristics

The data shown in table (2) which demonstrates the effects of rooting media, planting date and processing of grape cuttings, on the percentage of rooting success of cuttings, and its growth characteristics. The results demonstrate the clear superiority of the grape cuttings that were prepared and planted at the first date during January compared to those that were prepared and planted at the second date during February in all the characteristics of the cuttings and seedlings under study. There were clear significant differences in the mean percentage of cutting success, mean cutting height, average number of leaves and roots per cutting, average dry weight of leaves and roots (g/cutting), as well as average leaf area (cm^2/cutting), which were estimated two months after planting for both. Data in table 2 also shows the effect of various rooting media on all seedling characteristics, where the best results achieved when planted cuttings in Peatmoss compare to other rooting media, on the other hand the clay soil gave the lowest results for all seedling characteristics. These results agreement with **Hussein, *et al.,*** (2021), and this may be due to the fact that peat moss is considered one of the best organic materials that improve drainage and ventilation. It also prevents the formation of masses or compaction of soil particles, As a result, improvement of the cuttings root growth and its vegetative growth characteristics **(Lateef *et al.,*** 2018).

1- Successful cuttings (%)

Data shown that, the percentage of success of cuttings that were planted in Peatmoss increased by 5.2% and 9.8% compared to the clay soil (control) during the two planting dates, respectively. Also, the use of sandy soil mixed with sheep manure as a rooting media had a positive effect on the percentage of cuttings' success, as it led to an increase in the percentage of cuttings' success by 1.32% and 5.27% compared to the loamy soil (control) during the two planting dates, respectively. That result agree with **Hawezy**, in 2022, when study response cuttings of grape to pre-treatments and differences rooting media. This may be due to auxin accumulating within the cuttings and carbohydrates being transported downwards to complete the physiological process, rooting media such as can also provide a good favorable condition for early growth in the cuttings. This is consistent with the findings of **Kumar et al.,** 2015**; Awasthi, *et al.***, 2008. The similar results were also found in terms of the percentage of germinated cuttings with increasing doses of IBA,

which is due to the high accumulation of callus formation in the cuttings with the optimal dose of auxin, which leads to the highest percentage of germinated cuttings, which agreement with findings of **Kumar *et al.,*** 2015; **Bassan *et al.,*** 2009.

2- Seedling height (cm)

As data also indicates the influences of growing media on the seedling height in cuttings of grapevines, there were significant differences among various growing media. Peatmoss used as a soil growing media had the maximum seedling height (59.07 cm, and 30.96 cm) for both date of planting, respectively, while the lowest seedling height was when planted grape cuttings in clay soil as a control (48.67 cm, and 40.18 cm) for both date of planting, respectively.

3- Number of roots per cutting

The cuttings that were planted in peat moss achieved the best average number of roots per cutting during the two planting dates, as the number of roots increased by 25.29% and 22.8% compared to the clay soil for both planting dates, respectively. Also the mean number of roots increased by 17.82% and 14.29% compared to the mixture of sandy soil with sheep manure for both planting dates, respectively.

4- Number of leaves per cutting

The data shown that the cuttings which were planted in Peatmoss had maximum mean number of leaves per cuttings (30.33 and 22.13) for both planting dates, respectively, whereas the minimum number of leaves (19.27 and 8.31) was noticed by the cuttings which were planted in clay soil for both planting dates, respectively.

5- leaves dry weight (g/seedling)

In these three different rooting media, Peatmoss showed the highest mean of leaves dry weight per seedling during the both planting dates, whereas the first date was better than the second date an increase 37.05%. followed by usage the mixture of sandy soil with sheep manure (1:1 v/v) by mean increase 29.22%, and 86.88% compare with the lowest media (clay soil) as a control in both planting dates, respectively.

6- Roots dry weight (g/seedling)

Data also showed the differences of roots dry weight per seedling among the three of rooting media, where the cutting which were planted in Peatmoss gave the best mean of roots dry weight per seedling (18.21g, and 18.5 g) during the both planting dates, respectively. followed by usage the mixture of sandy soil with sheep manure (1:1 v/v) which recorded 14.32g, and 11.80 g/seedling, and the lowest media (clay soil) where reached 11.65g, and 8.74 g/seedling in the both planting dates, respectively.

7- Leaf area (cm^2/seedling)

The data on total leaf area per cutting were recorded، It could be shown that the different rooting media had significant effect on leaf area. The maximum leaf area (1466.4 cm^2) was recorded in the first date of planting during January treatment, while the minimum leaf area (274.25 cm^2) in the second time of planting during February treatment was obtained by clay soil (as a control).

Table 2 The effect of different rooting media, processing and planting date, on the rooting success of grape cuttings (Black Magic variety) and seedling characteristics

Rooting media	Av. the first date (January 2022 and 2023)						
	Successful cuttings (%)	**Seedling height (cm)**	**Number of roots**	**Number of leaves**	**leaves dry weight**	**Roots dry weight**	**Leaf area (cm^2)**
Clay soil	**84.44**	**48.67**	**33.51**	**21.38**	**19.27**	**11.56**	**477.89**
Sand+ manure	**85.76**	**54.73**	**36.76**	**27.62**	**24.90**	**14.32**	**808.36**
Peat moss	**89.64**	**59.07**	**43.31**	**38.62**	**30.33**	**18.21**	**1466.4**
	Av. the second date (February **2022 and 2023)**						
Clay soil	**69.49**	**40.18**	**25.36**	**17.13**	**8.31**	**8.74**	**274.25**
Sand+ manure	**74.76**	**44.13**	**27.09**	**24.20**	**15.53**	**11.80**	**550.59**
Peatmoss	**79.29**	**45.20**	**30.96**	**32.09**	**22.13**	**14.50**	**933.30**

Data in fig.1 show the influence of inter action between different concentrations of IBA treatments grape cutting pre planting, and various rooting media on the cuttings success (%), and the height of seedlings (cm). Where illustrate the best treatments were achieved the highest percentage cutting success when used IBA 2000 ppm concentration, and planted cuttings in Peatmoss which reached (94.07%, and 86.45%), respectively. As well as the mean of seedling height recorded the best results by treated grape cuttings pre planting by using IBA 2000 ppm, and planted it in Peatmoss media during the both planting dates were reached (73.73 cm, and 49.87 cm), respectively.

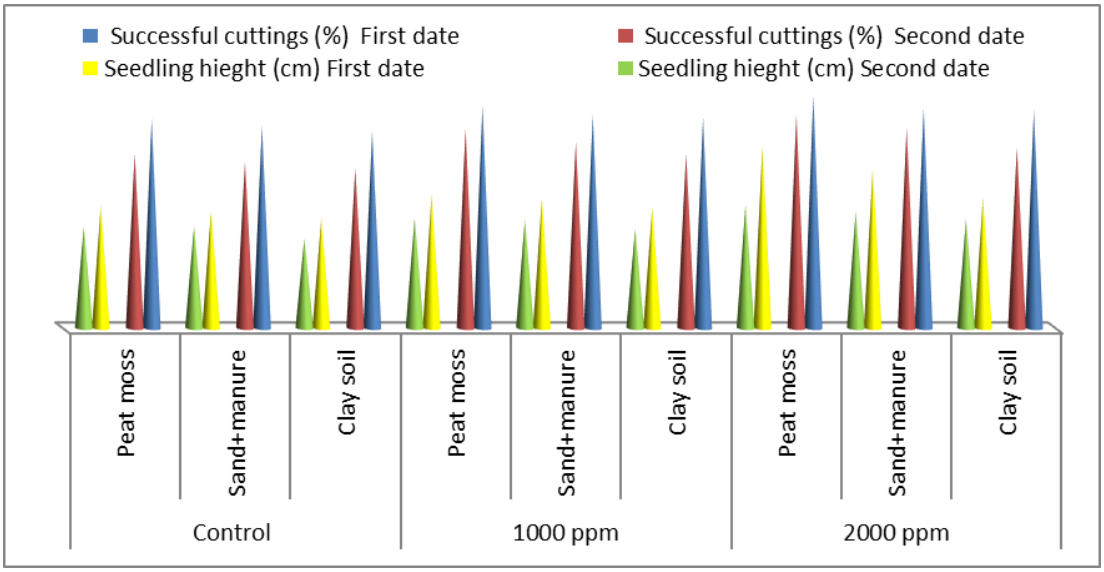

Figure (1) The effect of inter action between different concentrations of IBA treatments pre planting, and various rooting media on the mean of cuttings success (%), and height of seedlings (cm)

Results in figure (2) revealed that both IBA treatments improved number of roots and leaves per seedling grown in all different rooting media in comparison that grown in clay media as control. Similar to the previous results obtained with cuttings growth traits, the cuttings treated with 2000 ppm IBA in Peatmoss were the best in the two planting dates for the mean number of leaves and roots per seedling, which the mean leaves number amounted to 43.33, and 36.27 for two planting dates, respectively. On the other hand the mean roots number amounted to 52.8, and 36.53 for two planting dates, respectively.

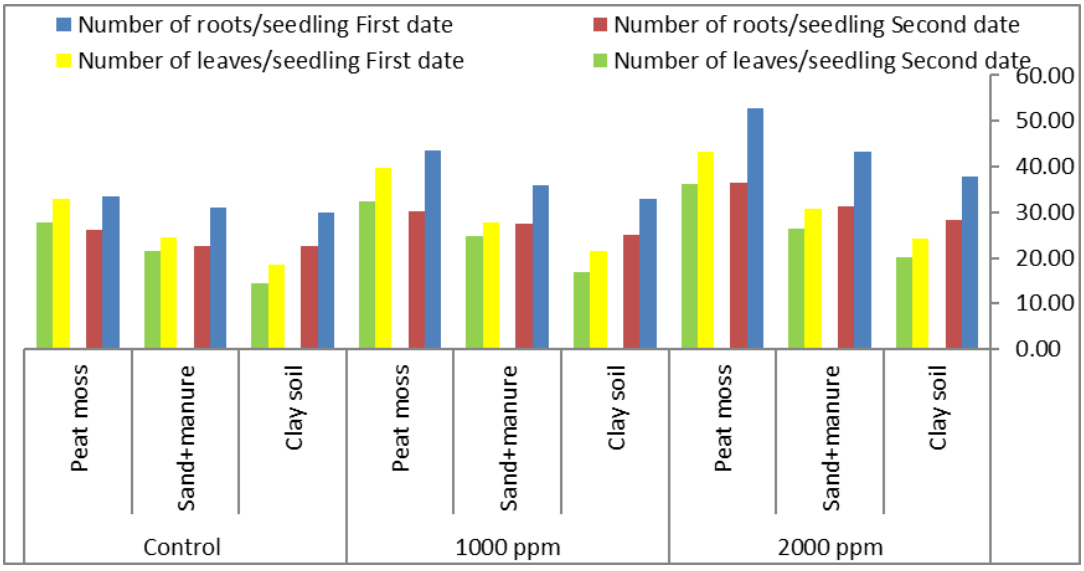

Figure (2).The effect of inter action between different concentrations of IBA treatments pre planting, and various rooting media on the mean number of leaves, and roots per seedling

Data in fig.3 show the impact of different concentrations of IBA treatments grape cutting pre planting, and various rooting media on the leaves and roots dry weight. According to the results discussed previously, this was reflected in the accumulation of dry matter in grape seedlings, which led to an increase in the average dry weight of leaves and roots during both planting dates. The results showed a superiority and increase the dry weight of leaves and roots for those cuttings that were treated with IBA 2000 ppm and then planted in Peatmoss. Where the increase reached 91.7%, and 378.7% for leaves and roots dry weight in the first planting date during January compare with control, respectively. As well as in the second planting date the mean of dry weight of leaves and roots increased by 143.17%, and 143.69% respectively, compare to control.

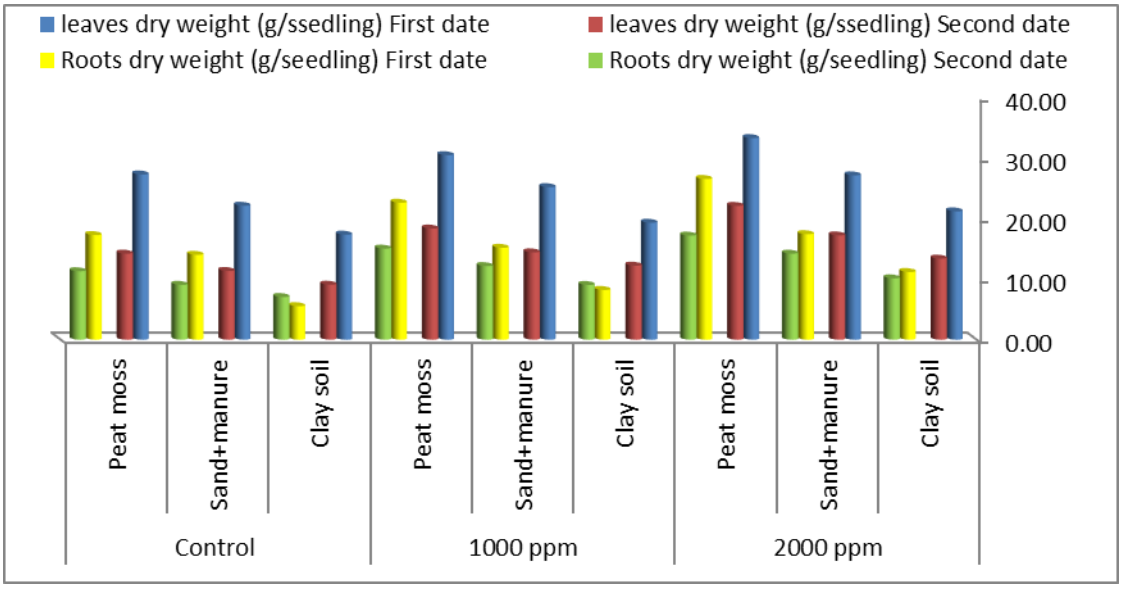

Figure (3).The effect of inter action between different concentrations of IBA treatments pre planting, and various rooting media on the mean leaves and roots dry weight (g/seedling)

Data in figure 4 presented the effect of IBA treatments pre planting, and various rooting media on the mean of leaf area (cm2/seedling). The results showed superiority and increase the leaves area for the cuttings that were treated with IBA 2000 ppm and then planted in Peatmoss. The maximum mean of leaf area per seedling reached 1713.04 cm^2/ seedling, and 1184.98 cm^2/ seedling in the first and second planting dates during January and February, respectively. This may be due to the use of auxin (IBA) play a main role of stimulated the growth of rooting and vegetative parts, these results were consistent with previous findings by **Kumar *et al.,*** 2015

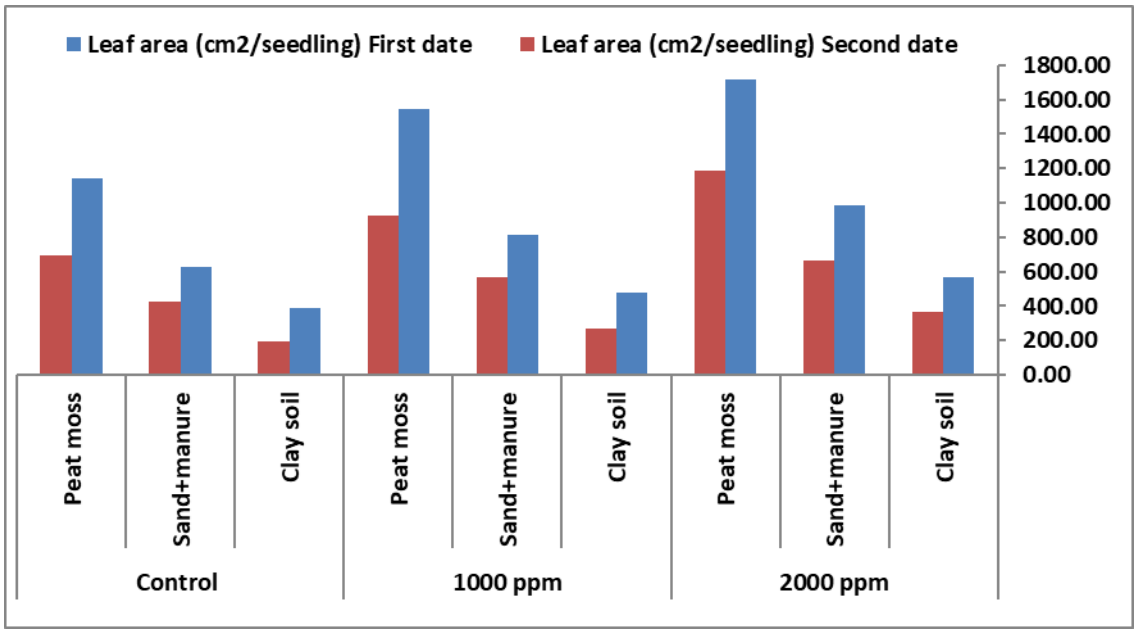

Figure (4). The effect of inter action between different concentrations of IBA treatments pre planting, and various rooting media on the mean of leaf area (cm^2/seedling)

CONCLUSION

According to the results of this current study, some of the grape cuttings characteristics were strongly impacted by the date of processing and planting, application of IBA as growth hormones (roots stimulator), as well as rooting media. However, in this study, the cuttings treatment of 2000 ppm IBA pre planting, for the cuttings which prepared and planting during January in Peatmoss gave the best results for all cuttings characteristics, and most effective for greatest success of rooting and growth.

REFERENCES

Abhinav Burman, R.N., Kanpure, S.R., Anjanawe, A., Haldar, R.P., Patel Singh,T. and Yadav, S.K., (2016). Effect of bio fertilizers and growth regulators on rooting and growth of hard wood cutting of grapevine (*Vitis vinifera* L.) cv. Thompson seedless Research in Environment and Life Sciences, 9 (12), pp.1522-1525.

Aboogiala, A., Fleafl, N., & Ahmed, E. (2021). Effects of IBA concentrations and different cultural media on the growth of two type grape cuttings of salt creek 'Ramsey'Rootstock. Scientific Journal of Agricultural Sciences, 3(2), 58-67.

Aghdaei, M., Nemati, S. H., Samiee, L., & Sharifi, A. (2019). Effect of rooting medium, cutting type and auxin on rooting of pepino (Solanum muricatum Aiton) cutting. Applied Ecology & Environmental Research, 17(5).

Alimam, N. A., & Agha, N. S. A. (2021). Rooting behavior of six grape cultivars (*Vitis vinifera* L.) using indole butyric acid. Zanco Journal of Pure and Applied Sciences, 33(1), 135-142.

Ariza-Sentís, M., Baja, H., Vélez, S., & Valente, J. (2023). Object detection and tracking on UAV RGB videos for early extraction of grape phenotypic traits. *Computers and Electronics in Agriculture*, *211*, 108051

Awasthi, P., Lal, S. and Singh, B. C. (2008). Influence of stooling time and IBA concentrations on growth attributes of stooled shoots in guava Pant Prabhat. Progressive Research, 3 (2): 154-156

Barcelo, A. M., Encina, C. L., & Perez, E. S. (1999). Micropropagation of adult olive. Pl. Cell Tissue Organ Cult, 36(3), 321-326.

Bassan, M. M., Mourão Filho, F. D. A. A., & Mendes, B. M. J. (2009). Rooting of'caipira'sweet orange+'Volkamer'lemon somatic hybrid cuttings and their progenitors. Revista Brasileira de Fruticultura, 31, 602-606.

Beniwal, B., Kumar, N., Kour, H., Pathlan, N., & Chhabra, A. (2022). The influence of plant growth regulators on the rooting of Grapes (*Vitis venifera*) wood cutting cv. Thompson Seedless. The Pharma Innovation Journal, 11(5), 1119-1122.

Chakraborty, S., & Rajkumar, M. (2018). Effect of growth regulators and organic substances on rooting of grapes (*Vitis vinifera* L.) cv. Muscat. Asian Journal of Science and Technology, 9(7), 8418-8421.

Childers, N.F.;Morris, J.R. and Sibbett, G.S. (1995). Modern fruit science. orchard and small fruit culture. Horticultural Publications. Gainesville, Florida. USA. P.632.

Daskalakis, I., Biniari, K., Bouza, D., & Stavrakaki, M. (2018). The effect that indolebutyric acid (IBA) and position of cane segment have on the rooting of cuttings from grapevine rootstocks and from Cabernet franc (*Vitis vinifera* L.) under conditions of a hydroponic culture system. Scientia horticulturae, 227, 79-84.

FAO STAT (2019). http://faostat.fao.org/

Florez-Sarasa I, Clemente-Moreno MJ, Cifre J, Capó M, Llompart M, Fernie AR, Bota, J. (2020). Differences in metabolic and physiological responses between local and widespread grapevine cultivars under water deficit stress. Agronomy, 10(7), 1052.

Galavi, M., Karimian, M. A., Mousavi, S.R. (2013). Effects of different auxin (IBA) concentrations and planting-beds on rooting grape cuttings (Vitis vinifera). Annual Research & Review in Biology: 517-523.

Ghangale, T. S., Patil, R. A., Ralebhat, B. N., Patil, O. B., & Hinge, A. M. (2021). Effect of IBA and cutting thickness on growth attributes of grape rootstocks (Vitis vinifera L.).

Ghosh, A., Dey, K., Mani, A., Bauri, F.K., Mishra, D.K. (2017). Effects of IBA on the rooting of branch cuttings of Chinese jujube (*Zizyphus jujuba Mill*.) and changes to nutrients and endogenous hormones. International Journal of Chemical Studies. 5(6):567-571.

Gomez, K.A., and Gomez, A. A. (1984). Statistical procedures for agricultural research. John Wiley & Sons.

Hartmann, H. T.; D. E. Kester; F.T. Davies and R.L. Geneve (2014). Plant propagation, principles and practices, Eight edition, Pearson Education Limited. Edinburgh Gate. Harlow. Essex CM20 2JE. England and Associated Companies throughout the world

Hussein, S. A., Medan, R. A., & Noori, A. M. (2021). Effect of different agricultural media and wounding on rooting and growing of Grapes (Vitis vinifera L.) semi wood cutting. *Eco. Env. & Cons*, *27*(1), 52-57.

International Organisation of Vine and Wine. (2021). State of the World Vitiviniculture Sector in 2020.

Kaur, G., Singh, S., & Singh, M. (2022). Growth regulators and sucrose application to improve the success rate of grape cuttings. Environ Sci. Arch, 1, 59-63.

Kumar, V., Singh, M. K., Kumar, M., Prakash, S., Kumar, A., Rao, S., & Malik, S. (2015). Effect of different doses of IBA and rooting media on rooting of stem cutting of lemon (Citrus limon Burm) cv. Pant lemon-1. *Journal of Plant Development Sciences*, *7*(7), 587-591.

Lateef, Mohammed Abdul Aziz, Noori, Ali Mohammed, Al-Qadi, Raghad and Mahdi Hadi Muhsin, (2018). The role of nitrogen and boron fertilizers on growth and yield in pomegranate (*Punica granatum* L.). Plant Archives. 18 : 1957-1960

Mehta SK, Singh KK, Harsana AS. (2018). Effect of IBA concentration and time of planting on rooting in pomegranate (*Punica granatum*) cuttings. Journal of Medicinal Plants Studies. 6(1):250-253.

OIV Statistical Report on World Vitiviniculture.2019.

Owais, S. J. (2010). Rooting response of five pomegranate varieties to indole butyric acid concentration and cuttings age. Pakistan Journal of Biological Sciences: PJBS, 13(2), 51-58

Rymbai, H., and Reddy, S. G. (2010). Effect of IBA, time of layering and rooting media on air-layers and plantlets survival under different growing nursery conditions in guava. Indian Journal of Horticultural. 67:99-104.

Satisha J, Adsule PG (2008). Rooting behavior of grape rootstocks in relation to IBA concentration and biochemical constituents of mother vines.Acta Horticulturae, 785: 121- 126.

Seiar, A. (2017). Effect of growth regulators on rooting of cuttings in pomegranate (*Punica granatum* L.) cv. 'Bhagwa'. Journal of Horticultural Science.11(2):156-160.

Shiozak, S.h., M. Masahiro, and O. Tsuneo (2013). Indole -3-acetic acid, polyamines and phenols in hardwood cuttings of recalcitrant-to-root wild grapes native to east asia. *Vitis davidil* and vitis kiusiana. J. of Botany, Vo. Article ID 819531, P. 1-9.

Shukla, H.S., Tripathi, V.K., Awasthi, R. D., Tripathi, A.K., (2010). Effect of IBA, PHB and boron on rooting and shoot growth of hard wood stem cuttings of Peach. International Journal of Applied Agricultural Research. 5(4):467-473.

Stancato, G. C., Aguiar, F. F. A., Kanashiro, S., Tavares, A. R., Catharino, E. L. M., & Silveira, R. B. D. A. (2003). Rhipsalis grandiflora Haw.(Cactaceae) propagation by setem cuttings. Scientia Agricola, 60, 651-656.

Weaver, R.J. (1976). Grape growing, Wiley-Inter Science, NY, USA

Wynne, J., & McDonald, M. S. (2002). Adventitious root formation in woody plant tissue: the influence of light and indole-3-butyric acid (IBA) on adventitious root induction in Betula pendula. In Vitro Cellular & Developmental Biology-Plant, 38, 210-212.

الملخص العربي

تقييم سلوك تجذير عقل العنب (*Vitis vinifera* L.) تحت أوساط مختلفة وتركيزات IBA

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أجريت هذه الدراسة على فترتين لجمع وتحضير عقل العنب (Black Magic cv.) خلال عامي (2022 ، 2023) لتقييم أفضل الممارسات التي يمكن تطبيقها للحصول على أفضل عقل وشتلات العنب ومن ثم تعزيز إنتاج العنب. أجريت التجارب في مزرعة خاصة في منطقة الجبل الأخضر بمدينة البيضاء، ليبيا. حيث تم معاملة العقل بثلاثة تركيزات مختلفة من IBA عند 0 (سيطرة)، 1000 جزء في المليون، 2000 جزء في المليون، في ثلاثة أوساط تجذير مختلفة (تربة طينية، رمل + روث الأغنام، بيتموس) خلال موعدين مختلفين لجمع عقل العنب وتم زراعتها خلال شهري (يناير، وفبراير). وبعد شهرين من معاملة وزراعة عقل العنب تم تقدير النسبة المئوية لنجاح العقل، متوسط إرتفاع الشتلة، متوسط عدد الجذور/شتلة، متوسط عدد الأوراق/شتلة، الوزن الجاف للجذر والأوراق/شتلة، ومتوسط مساحة سطح الأوراق/شتلة خلال فترة الدراسة.

أظهرت النتائج أنه تم الحصول على أفضل أداء تجذير عندما تمت معالجة عقل العنب المزروعة في البيتموس قبل الزراعة بمقدار 2000 جزء في المليون IBA خلال الموعد الأول للتحضير وزراعة العقل (خلال شهر يناير). حيث أعطي أفضل نسبة مئوية لنجاح زراعة العقل والتي بلغت 89.6%، وكذلك باقي صفات الشتلات المدروسة.

الكلمات الدالة: IBA، عقل العنب، البيتموس