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Why Some Grapevine Cultivars Are Hard to Root?

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Abstract: Criteria of rooting ability, levels of endogenous hormones (IAA, GA_3 and ABA) and nutritional status of stem cuttings (carbohydrates %, N %, Zn and B as ppm) were evaluated within eight grapevine cvs cuttings. Three grapevine cvs as readily to root cvs (Thompson seedless, Flame seedless and Superior) and five grapevine cvs as hard to root cvs (Salt Greek, Harmony, Ramsey, Freedom and Dog Ridge) were selected. Endogenous hormones as well as organic and inorganic nutrients in the basal tissues of cuttings were determined at the end of each season (2009 and 2010). Easy to root grapevine cv cuttings were characterized by higher levels of Rooting %, No. of roots, Root length (cm), Root distribution (cm^2) and Survival, IAA, total carbohydrates, C/N, Zn and B and lower levels for GA_3, ABA and N. An obvious increment was observed for GA_3, ABA and N in difficult to root grapevine cv cuttings. Criteria of rooting in such hard to root grapevine cuttings were greatly declined. The ability of different grapevine cv cuttings to root easily was associated with the balancing occurred between the three endogenous hormones- like substances namely IAA, GA_3 and ABA as well as total carbohydrates, Zn and B. Generally, it is suggested to dip of hard to root grapevine cv cuttings in any indolic, Zn and B compounds as well as selecting the suitable thickness of cuttings for enhancing rootability.

Key words: Grapevine, rooting, endogenous hormones, nutritional status, easy and hard to root cutting.

INTRODUCTION

Why do cuttings form some species root readily whereas cuttings from other species are extremely slow, or reluctant to from roots? This question has been the basis for much research on this subject (Haissing and Davis 1994), but despite many important advances there remains much to learn about the biochemistry and physiology of adventitious rooting. There is considerable commercial interest in this question, since vegetative propagation by cuttings can be an efficient method for producing large numbers of plants, and is thus an attractive technique for the plant propagation industry, but for many hardy ornamental species it is not always successful.

It is clear that endogenous auxin, indole- 3- acetic acid (IAA), plays a central role in adventitious rooting (De Klerk *et al*., 1999). Endogenous IAA is believed to be synthesized in apical parts of plant stem (shoot apices and young leaves) and transported in a basipetal fashion down the plant stem via the polar transport pathway, considered to occur in living tissue close proximity to vascular tissues, e.g. phloem parenchyma (Moore, 1989). Basipetally transported IAA might therefore be expected to accumulate, although perhaps only transiently, at the base of a cutting excised from a stem. A number of possible differences between IAA transport and IAA accumulation in cuttings of easy- and difficult- to- root plants can be hypothesised. Cuttings from difficult- to- root plant may metabolize IAA faster than those from easy- to- root plants, resulting in lower basal free IAA concentrations, or there may be a lower rate of basipetal IAA transport in stems of difficult- to- root plants; there may be a greater concentration of factors inhibitory to rooting in the bases of cuttings from difficult- to- root plants, and the cells that give rise to adventitious root primordia may be less sensitive to auxin, or less competent for re- differentiation in difficult- to- root plants than in easy- to- root plants. It is likely that several factors are involved in conjunction; the limitation to rooting in a difficult- to- root plant is un- likely to be due to one simple cause (Willkins, 1969).

The balance naturally occurring between various endogenous hormones- like substances as well as N, carbohydrates, C/N, B and zinc in fruit tree cuttings plays an important role in success of rooting process. Why certain cuttings are hard to root?. The answer emphasized the importance of existing highly specific root

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forming substances. During the formation of roots in cuttings, the first step is the differentiation depending upon the proportion of Indole acetic acid (IAA) to other natural hormones i.e. Gibberellic acid (GA_3) and Abscisic acid (ABA) present in the cuttings. When IAA was applied high root primordia developed. Tissues of easy- to- root fruit tree cuttings have repeatedly shown to have a higher IAA than those difficult to- root cuttings. The natural auxin namely IAA has been though to enhance enzyme activity thus increased starch hydrolysis and facilitated mobilization (Ford *et al*., 2001).

Chemical composition of the cuttings has been related to their physiological behavior and rooting response. The natural balancing occurred among carbohydrates and nitrogen as well as zinc and boron contents in fruit cuttings after taking from mother plants effectively controlled and governed the success of rooting process. In addition, C/N in these cuttings did not neglect in this connection. (El- Morsy *et al*., 1993; Seagle *et al*., 1995; Reiley and Shry, 1997; Nelson, 2000 and Skirvin, 2004).

Zinc is a component of a number of enzymes and acts as an enzyme co- factor. This element is required for the formation of tryptophan, which is a precursor for the auxin IAA (Swietlik, 1999).

Stem cutting is considered to be the most simple and economical method of propagation. It is important, particularly in horticulture for mass production of improved plant material in a short time and to perpetuate the characteristics of the parent plants. The rooting potential of cuttings of different plant species, however varies considerably. Some of them root easily while others can not root even with the application of growth substances (Debnath and Maiti, 1990; Abo- Rawash, *et al*., 1993; Singh *et al*., 1995 and Nelson, 1999).

The target of this study was finding out the answer about the definite question namely why some grapevine cvs are hard to root.?

MATERIALS AND METHODS

This investigation was carried out during two successive seasons of 2009 and 2010 in a private nursery located at West Samalout, Minia Governorate, Egypt. Shoots moderate in vigour of the preceding season were collected from the eight grapevine cvs (three easy to root grapevine cvs namely: Thompson seedless, Flame seedless and Superior and five hard- to- root grapevine cvs namely Salt Greek, Harmony, Ramsey, Freedom and Dog Ridge). Vines were of about ten years old at the start of experiment. Hard cuttings were prepared from good prunings.

The selected cuttings from each grapevine cv were prepared of about 15 cm. long and 0.9 cm. in diameter and include five eyes. They were taken from middle parts of each shoot. All cuttings for all grapevine cvs were planted to a depth of five cm. in plastic flat filled with a mixture of vermiculite, peat moss and sand (1: 1: 1) by volume. Plates were hold at greenhouse for three months. The experiment involved eight treatments from eight grapevine cvs. Each treatment was replicated five times, ten cuttings per each replicate (50 cuttings per each grapevine cv.)

The experiment was set up according to the complete randomized design.

For determination of endogenous hormones namely IAA, GA_3 and ABA, samples from the basal portions of cuttings for each grapevine cvs were taken and keep in methanol at -20 ° C until fractionation. The procedures of Fadl and Hartmann (1967) and Browning and Wignall (1987) for fractionation were followed to isolate these natural hormones. Nutritional status of cuttings was determined in terms of measuring percentages of total carbohydrates and nitrogen and their contents from Zn and B. All of them were determined in the basal portions of cuttings according to the procedures that outlined by Piper (1950) and A.O.A.C (1995).

At the end of experiment (three months after planting), the following parameters were measured:-

1. Rooting percentage.
2. Number of roots per cuttings.
3. Root length (cm.).
4. Root distribution (cm^2).
5. Survival %.

Data were collected and statistically analysed. Comparisons among treatments means were made by using New L.S.D test according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Root Characters and Survival %:

As shown in Table (1) and Figures (1&2&3) great and significant differences on the percentage of rooting, root distribution, number of roots/ cuttings, root length and survival % were existed among easy and hard to

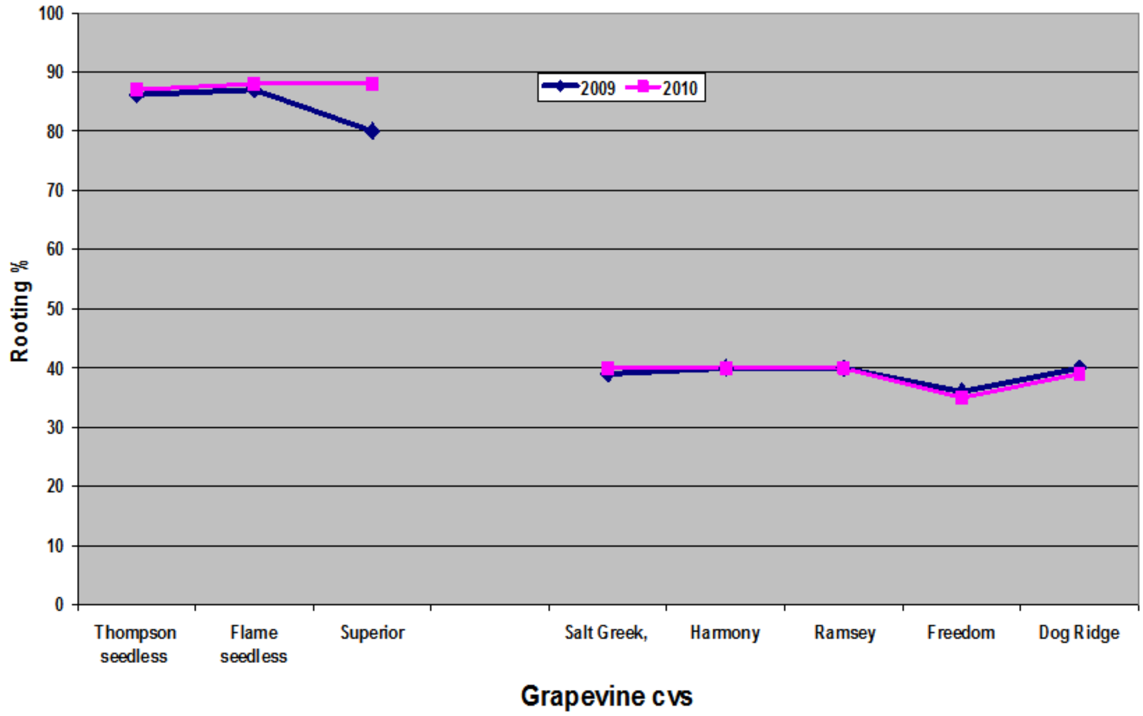

Fig. 1: Rooting % of easy and hard to root grapevine cv. cuttings during 2009 and 2010 seasons.

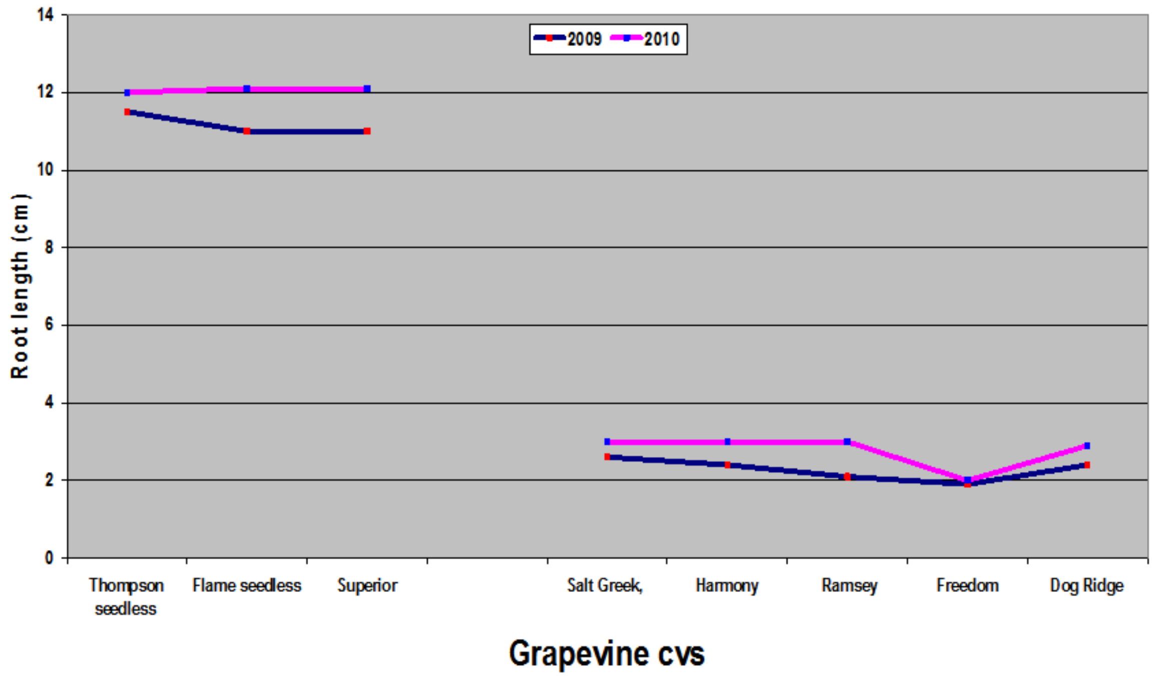

Fig. 2: Rooting length (cm) of easy and hard to root grapevine cv. cuttings during 2009 and 2010 seasons.

root grape cuttings. The maximum vales of these parameters were recorded on easy to root grapevine cuttings (Thompson seedless, Flame seedless and Superior) comparing with those produced from difficult to root grapevine cuttings (Salt Greek, Harmony, Ramsey, Freedom and Dog Ridge).

The presence of IAA, carbohydrates, C/N and Zn at higher levels in easy to root cuttings and lower levels in hard to root cuttings could ascertain the view about the possible contribution of the compound with rooting

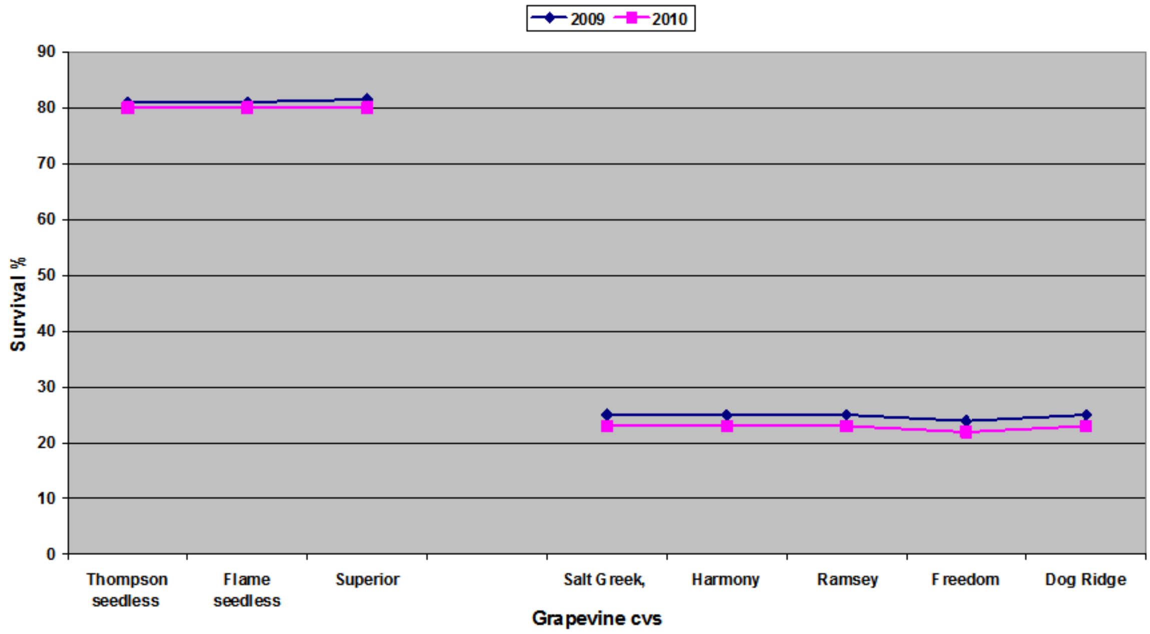

Fig. 3: Survival % of easy and hard to root grapevine cv. cuttings during 2009 and 2010 seasons.

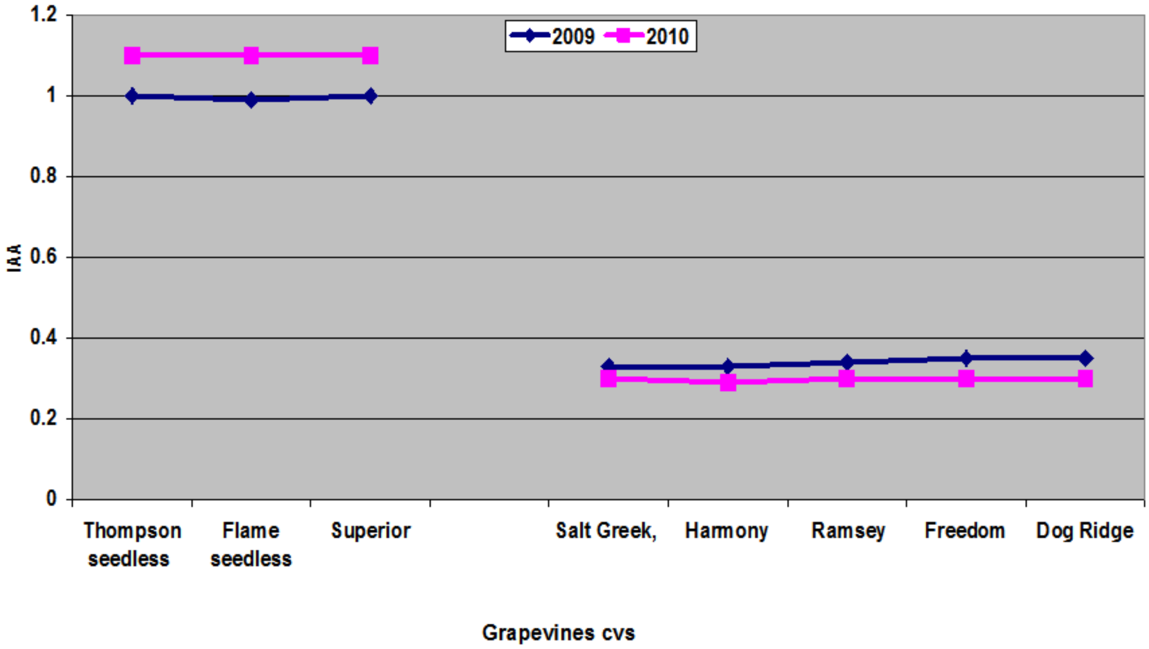

Fig. 4: Indol acetic acid (mg/100 g F.W) of easy and hard to root grapevine cv. cuttings during 2009 and 2010 seasons.

ability of the various grape cvs. Easy to root cutting had low level of GA_3 and ABA which are considered inhibitors of root formation. It may be concluded that there are several important factors related to the root ability of cuttings. These factors are generally higher value of IAA, carbohydrates, B and Zn and lower content of GA_3, ABA and N in grape cuttings. The positive effects of IAA and Zn in enhancing root primordia and activity of different enzymes could result in stimulating root formation. The same trend was observed by Abou Rawash *et al*., (1993) and Nelson, (1999).

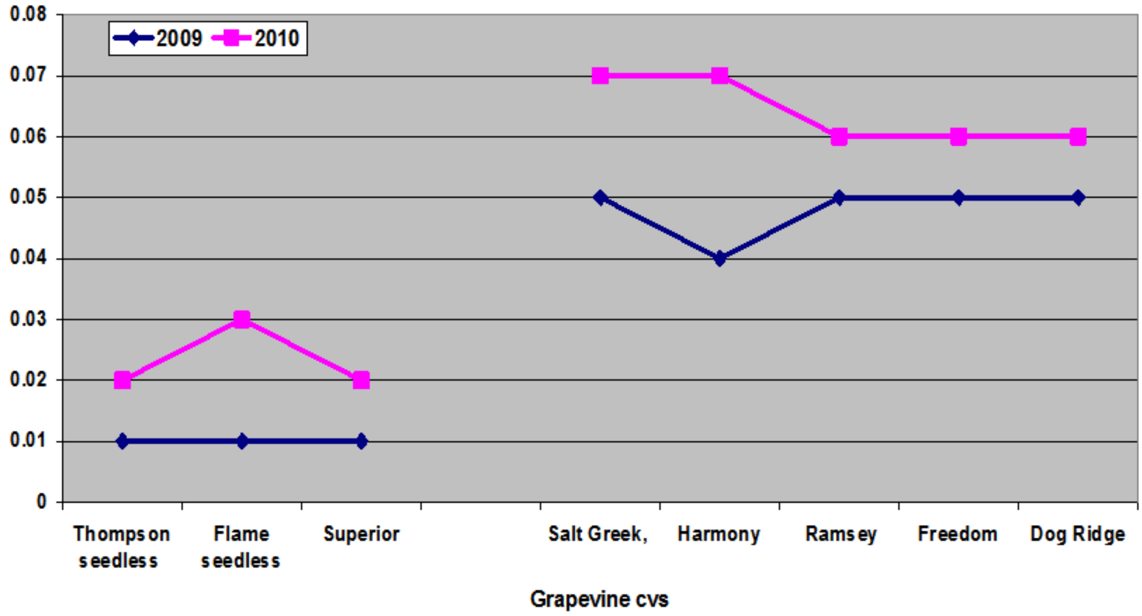

Fig. 5: Absisic acid (mg/100 g F.W) of easy and hard to root grapevine cv. cuttings during 2009 and 2010 seasons.

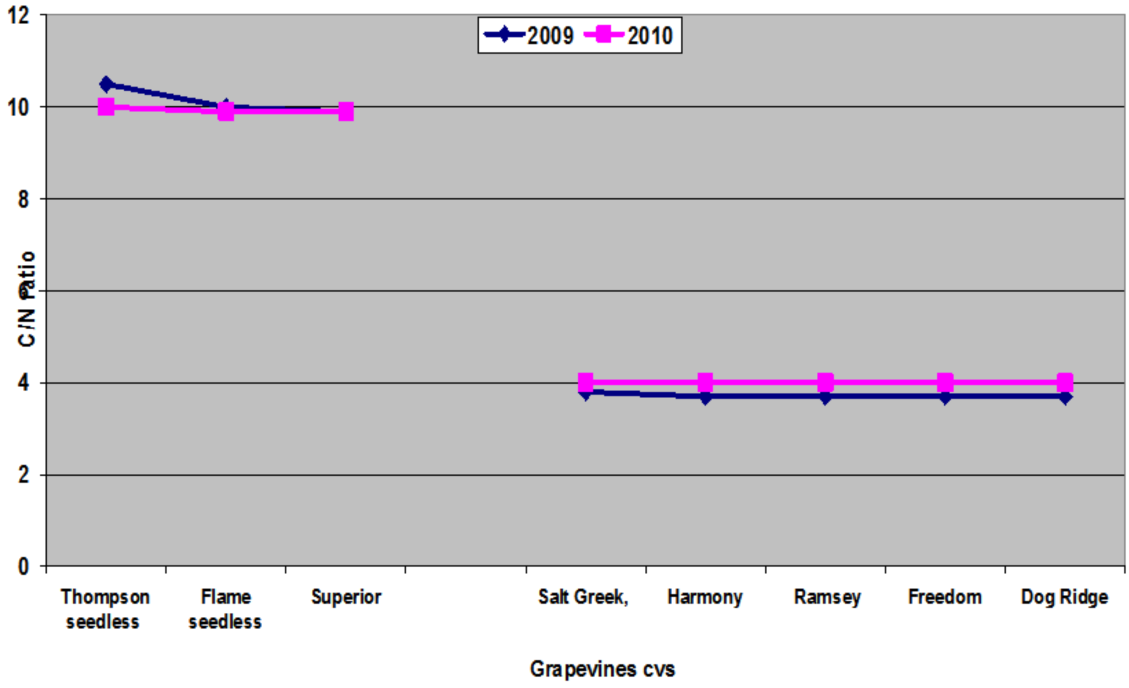

Fig. 6: C/N ratio of easy and hard to root grapevine cv. cuttings during 2009 and 2010 seasons.

2- Endogenous Hormones and Nutritional Status of Cuttings:

It is clear from the data in Table (2) and Figures (4&5&6) that endogenous hormones and percentages of total carbohydrates and nitrogen as well as Zn and B contents in cuttings were significantly varied according to grapevine cvs. Case of rooting had significant effect on all cuttings constituents. Results showed that in easy to root grapevine cv namely (Thompson seedless, Flame seedless and Superior) cuttings, the endogenous IAA, total carbohydrates, C/N, Zn and B were the highest, whatever the other hormones i.e. GA_3 and ABA as well as N % were the lowest comparing with those in hard to root grapevine cv. cuttings (Salt Greek, Harmony, Ramsey, Freedom and Dog Ridge).

Table 1: Root characters and survival % of easy and hard to root grapevine cv. cuttings during 2009 and 2010 seasons.

Grapevines cvs	2009					2010				
	Rooting %	No. of roots	Root length (cm)	Root distribution (cm^2)	Survival %	Rooting %	No. of roots	Root length (cm)	Root distribution (cm^2)	Survival %
a- Easy to root grapevine cvs										
Thompson seedless	86.2	18.0	11.5	71.0	81.0	87.0	19.0	12.0	72.0	80.0
Flame seedless	87.0	18.3	11.0	70.6	81.0	88.0	19.0	12.1	72.0	80.0
Superior	80.0	18.9	11.0	71.0	81.5	88.0	19.0	12.1	72.4	80.0
b- Hard to root grapevine cvs										
Salt Greek,	39.0	4.0	2.6	15.0	25.0	40.0	4.5	3.0	15.5	23.0
Harmony	4.0	4.0	2.4	15.5	25.0	40.0	4.5	3.0	16.0	23.0
Ramsey	40.0	3.6	2.1	16.0	25.0	40.0	4.0	3.0	16.0	23.0
Freedom	36.0	3.0	1.9	14.6	23.9	35.0	3.1	2.0	14.5	21.9
Dog Ridge	40.0	4.0	2.4	16.0	25.0	39.0	4.0	2.9	15.3	23.0
New L.S.D at 5%	4.1	4.1	0.8	1.5	1.4	5.0	1.5	1.1	1.2	1.3

Table 2: Endogenous hormones (mg/ 100 g F.W) and nutritional status of easy and hard to root grapevine cv. cuttings during 2009 and 2010 seasons.

grapevine cvs	2009								2010							
	Hormones (mg/ 100 g F.W)			Carbo-hydrates %	N%	C/N	Zn (ppm)	B (ppm)	Hormones (mg/ 100 g F.W)			Carbo-hydrates %	N %	C/N	Zn (ppm)	B (ppm)
	IAA	GA_3	ABA						IAA	GA_3	ABA					
a- Easy to root grapevine cvs																
Thompson seedless	1.00	0.74	0.01	20.0	1.9	10.5	80.0	60.0	1.1	0.76	0.02	20.0	2.0	10.0	84.0	69.0
Flame seedless	0.99	0.75	0.01	19.9	2.0	10.0	81.0	61.0	1.1	0.77	0.03	19.8	2.0	9.9	85.5	70.0
Superior	1.00	0.75	0.01	19.8	2.0	9.9	81.0	61.0	1.1	0.77	0.02	19.8	2.0	9.9	85.5	70.0
b- Hard to root grapevine cvs																
Salt Greek,	0.33	3.71	0.05	11.1	2.9	3.8	22.0	11.0	0.30	3.41	0.07	12.0	3.0	4.0	25.6	12.6
Harmony	0.33	3.75	0.04	11.0	3.0	3.7	22.2	11.0	0.29	3.44	0.07	12.0	3.0	4.0	25.8	12.6
Ramsey	0.34	3.71	0.05	11.0	3.0	3.7	22.2	11.5	0.30	3.44	0.06	12.0	3.0	4.0	25.8	12.0
Freedom	0.35	3.71	0.05	11.0	3.0	3.7	22.4	11.4	0.30	3.50	0.06	12.0	3.0	4.0	25.8	12.8
Dog Ridge	0.35	3.72	0.05	11.0	3.0	3.7	22.4	11.5	0.30	3.50	0.06	12.1	3.0	4.0	26.0	12.8
New L.S.D at 5%	0.30	0.49	0.02	1.9	0.8	1.1	1.9	2.2	0.29	0.50	0.03	1.8	0.7	1.2	2.0	2.3

Therefore, it could concluded that IAA is possibly among factors controlling rooting of the grape stem cuttings. In this connection (Ford *et al*., 2001) found that rooting has been related in most cases to the presence of accumulation of the natural auxin namely IAA in the bases of cuttings. Swietlik (1999) stated that Zn is a precursor for the auxin IAA. Skirvin (2004) ensured the beneficial effect of carbohydrates on forming of root primordia.

This conclusion goes in parallel with that found by Seagle *et al*., (1995); Reiley and Shry (1997) and Nelson (2000). However, the lower concentration of both ABA and GA_3 in hard to root cutting (Salt Greek, Harmony, Ramsey, Freedom and Dog Ridge) and the greatest values for both hormones (IAA and GA_3) in (Thompson seedless, Flame seedless and Superior) cuttings could answer the question why difficult to root cuttings (Salt Greek, Harmony, Ramsey, Freedom and Dog Ridge) are hard to root. The inhibition of GA_3 to root formation is a direct local effect that prevents the early cell division involved in transformative of mature stem tissues to a meri- stematic condition (Skirvin, 2004) Gibberellic acid has a function in regulation of nucleic acid and protein synthesis and may be a suppressing for root initiation (El- Morsy *et al*, 1993). Lowering the natural level of GA_3 in the tissues should stimulate adventitious root formation in cuttings (De Klerk, 1996). The lower concentration of ABA in the easy vine to- root vine cuttings may indicate that this plant regulator do not play an important role in root initiation. This finding confirmed the work done by Moore (1989). In fact, reports on the effect of ABA on adventitious root formation are contradictory (Ford *et al*., 2001) apparently depending upon the concentration and upon the nutritional status of the parents which the cutting are taken.

The relationship between the chemical composition of the cuttings and the rooting ability goes in the same line with that reached by Fadl and Hartmann (1967) and Reily and Shry (1997).

As a conclusion, these results confirmed that it is possible for solving the poor of rooting in different grape cvs by dipping cuttings on solution containing IBA, IAA, Zn and B. Hormonal and nutritional status of the cuttings are considered important factors controlled rooting of different grapevine cvs.

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