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A REVIEW ON VEGETATIVE PROPAGATION OF GRAPE (*VITIS VINIFERA* L) THROUGH CUTTING

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ABSTRACT
Grape (*Vitis vinifera* L.) belongs to the Vitaceae family. Grape is normally propagated through stem cuttings. Vegetative propagation in fruit crops works faster than seed propagation. Auxin application has been found to enhance the histological features like formation of callus and tissue and differentiation of vascular tissue. Internal factors affecting rooting of cuttings include the amount of stored food in cuttings, the age and maturity of tissue, the formation of callus and adventitious roots and the presence of leaves and buds on cuttings. Rooting media is one of the most important factors for rooted cutting production. It is one of the factors affecting rooting and growth of grape cuttings.

KEYWORDS: Grape, Rooting media, planting time, IBA, Rooting.

INTRODUCTION

The grape (*Vitis vinifera* L.) belongs to the Vitaceae family, which includes about 60 species of wild Vitis distributed in Asia, North America, and Europe under subtropical, Mediterranean and temperate continental climate. It is native to the Mediterranean region, central Europe, and southwestern Asia, from Morocco and Portugal north to southern Germany and east to northern Iran. The major uses of grapes are; wine making, fresh fruit (table grapes) and dried fruit (raisins) production. It can be used for making wine, jam, juice, jelly, grape seed extract, ethanol, raisins, vinegar, grape seed oil, tartaric acid, fertilizer, grape derived antioxidant compounds (polyphenols, resveratrol) and etc. Grape also associated with prevention of cancer, heart disease, high blood pressure, allergies, diabetes, constipation *etc* (Haile Abebe, 2017).

Grape propagation for commercial vineyards includes the use of cuttings, rooting, budding, layers and grafts (Verdegaal, 2009). Rooting media is one of the most important factors for rooted cutting production. It is one of the factors affecting rooting and growth of grape cuttings (Abebe, 2017). Hartmann and Kester (1983) stated that best rooting was usually found in cuttings taken from the basal portion of the shoots. This was referred to the possibility of higher accumulation of carbohydrates and concentration of endogenous root- promoting substances that were produced in buds and leaves. Types of media have significantly influenced the rooting and vegetative growth of cuttings. Growing media should be considered an essential part of the propagation system because rooting competency depends on the type of medium used. Rooting medium directly effect on quality and percentage of rooting (Farooq, 2018). Both the biological and physico-chemical characteristics of a potting medium affect plant and root growth (Abebe, 2017). It is known that good growth media provides a reservoir for plant nutrients, hold plant available water, and provide a means for gas exchange and good anchorage for the plants (Galavi *et al*. 2013). Patil (2000) studied the effect of growth regulators on rooting of cuttings in two commercial varieties of grape *Vitis vinifera* L. He treated with IBA, NAA and their combination with different concentrations. He found that, almost all root characters, and fresh and dry weight of roots were non-significant. As regards to different concentrations of growth regulators, IBA at 100ppm followed by NAA at 100 ppm gave a better survival percentage and higher number of primary roots than other treatments. The greatest length of the root was produced following treatment by IBA at 300ppm and NAA at 300 ppm Combination of (IBA + NAA) was detrimental to almost all root characters and survival percentage of cuttings.

Among the different concentrations of IBA, 2000 ppm for hardwood cuttings and 500 ppm for soft wood cuttings were found to be the optimum concentrations for obtaining the highest percentage of rooting and number of roots and longest root length per cutting in Dogridge and 1613C rootstocks (Rao, 2004). Rooting media is one of the most important factors for rooted cutting production. It is one of the factors affecting rooting and growth of grape cuttings (Haile Abebe 2017). Types of media have significantly influenced the rooting and vegetative growth of cuttings. Growing media should be considered an essential part of the propagation system because rooting competency depends on the type of medium used. Rooting medium directly effect on quality and percentage of rooting (Farooq *et al*., 2018). It is known that good growth media provides a reservoir for plant nutrients, hold plant available water, and provide a means for gas exchange and good anchorage for the plants (Galavi, *et al*., 2013). Ferguson *et al*. (1986), Ferri (1997) and Abou-Rawash *et al*. (1998). They have indicated several factors responsible to the callus formation of stem cuttings, such as age and

mother plant vigour, woodiness and location of the stem cutting, growth regulators, environment, nutrition and genetic factors related to the genus or species of interest.

Effect of IBA concentration

Auxin application has been found to enhance the histological features like formation of callus and tissue and differentiation of vascular tissue (Mitra and Bose, 1954, Singh, 2018). Bhattacharya (1959) reported that 75 ppm IAA in leaf mould proved the best followed by 100 ppm IAA in soil for rooting of Anab-e-Shahi hardwood cuttings. While Navneethan (1964) obtained higher percentage of rooting in grapevine cuttings of Gulabi, Bhokri, Thompson Seedless and Anab-e-Shahi cultivars with the application of IBA 200 ppm or NAA 100 ppm. Shisode (1964), however, found 25 ppm IBA to be adequate for Phakdi and Bangalore Purple cultivars. Sariskova (1964) reported that soaking the cuttings for 8-12 hours in IBA 100 ppm or IAA 200 ppm or NAA 50 ppm improved the rooting significantly in grapevine cuttings. IBA at 25 ppm was found to be better in improving the percentage of rooting in Khandhari variety of grapevine. Gangwar and Singh (1968) obtained best rooting (83.3 per cent) and greater number of roots and leaves with 50 ppm IBA. While, Singh *et al*. (1971) got 79.5 per cent rooting in grape cv. Perlette with 500 ppm IBA. It was observed that further increase in the concentration of IBA decreased the rooting percentage at a faster rate. It was only 3.75% at 4000 ppm concentration of IBA.

Mokashi (1977) reported that soaking of Thompson Seedless cuttings in 250 ppm IBA solution for 12 hours was adequate to induce highest percentage of rooting. On the other hand, Singh and Singh (1973) obtained better rooting at 500 ppm IBA but higher concentrations at 2000 and 4000 ppm were detrimental in cuttings of Thompson Seedless, Perlette and Himrod varieties of grape. Contrary to that, Singh *et al*. (1986), failed to obtain favourable response by treating either thick or thin cuttings with 500 ppm IBA. Moretti and Ridome (1983) emphasized that the use of growth regulators at higher concentration resulted adversely on the production of (marketable) rooted cuttings in grapevine rootstocks. On the other hand, Chadha (1984) observed that treatment with IBA 2500 ppm by quick dip method for 15 seconds resulted in 100 per cent rooting in difficult to root stocks, Dogridge and Salt Creek. Reddy (1984) obtained better rooting in Anab-e-Shahi cuttings from current seasons growth treated with IBA + NAA at 2500 ppm. According to him, basal or subterminal cuttings gave higher percentage of rooting.

Patil *et al*. (2001) however, reported that combination of growth regulators (IBA + NAA) was injurious and recorded less percentage of survival. Coppala and Forlani (1985) also obtained good rooting in cuttings of grape rootstocks, 420 A (45%), KBB (75%) and 41 B (50%) with IBA 2000 ppm. Similarly, Fabbri and Lambardi (1988) reported higher percentage of rooting (81%) in 140 Ruggeri grape rootstock (*Vitis berlandieri* and *Vitis rupestris*) with 2000 ppm IBA. Sunitha (1991) studied the effect of different plant growth regulators (IAA, IBA and NAA) at four concentrations (1000, 2000, 3000 and 4000 ppm) on rooting of four grape varieties, Gulabi, Kishmish Rozoviz, Tas-A-Ganesh and Thompson Seedless and reported that IBA 2000 ppm gave best results with respect to percentage of rooting, number of roots, longest root, diameter of the root, fresh root weight, mean root volume,

dry root weight, number of leaves and percentage of establishment in all four varieties.

Reddy *et al*. (1996) studied the response of cuttings of 13 grape hybrids and varieties to seven concentrations of IBA and NAA at Bangalore and found that rooting percentage and mean root length were greatest with 1250 ppm IBA, while root number per cutting was highest with 2500 ppm IBA and rooting percentage was highest in cv. Bangalore Blue. Kawai (1996) observed that application of 100 ppm IBA or NAA as overnight dips to the disbudded hardwood cuttings of grape cv. Muscat Bailey A increased rooting percentage after 40 days from 5 per cent in control to 100 per cent. Zhang *et al*. (1997) reported that the percentage of rooting in grape cv. Fenghuang 51 was 83-93 per cent with six numbers of roots (on average) per cutting when treated with 50 or 100 ppm IBA or 150 ppm NAA. Aminobenzotriazole (ABT) rooting powder-2 also gave good results, but they were no better than those for IBA and NAA.

Song *et al*. (2001) obtained best rooting when the base of the cuttings were soaked in a solution of 150 ppm IBA or NAA for 24 hours in four grape varieties derived from crosses involving *Vitis amurensis*. Patil et al. (2001) observed that soaking the cuttings for 6 hours either in IBA (100 ppm) or NAA (100 ppm) recorded maximum survival percentage (86.33 and 76.00, respectively) in the cutltivars Tas-A-Ganesh and Kismish Chorny. Higher concentrations (300 or 200 ppm), however, proved detrimental and the survival percentage was significantly reduced. They also reported that combination of growth regulators (IBA + NAA) was injurious and recorded minimum survival percentage than other treatments. Garande *et al*. (2002) reported better sprouting percentage by dipping the cuttings in IBA 1500 ppm for 30 seconds in rootstocks Dogridge and Salt Creek. Keeley *et al*. (2003) observed the Hardwood and softwood cuttings of *Vitis aestivalis* Michx rooted under intermittent mist in a series of experiments using cuttings collected from two local vineyards. Hardwood cuttings treated in late March responded in a similar manner to KIBA and KNAA. Although there was little increase in the percentage rooting, root number increased linearly on cutting. Cuttings treated with 10000 mg l^{-1} auxin produced up to 4 times more roots than the non treated controls.

(Burman *et al*. 2016) was observed that the maximum success percentage, number of shoots per cutting, total no. of leaves per cutting, leaf area index, No. of roots per cutting, length of roots was recorded under 2000ppm concentration of IBA. Ahmed *et al*. (2017) Observed that the maximum mean number of sprouts cutting-1 (6.33), leaves cutting-1 (20.50), roots cutting-1 (95.83) and fresh weight of roots (13.43 g) was achieved in response to NAA1 (1000 mg L -1). However, there was no significant effect of NAA on sprouting and rooting percentages. In varietal comparison, Crimson seedless produced significantly higher number of leaves (18.91) and number of roots cutting-1 (82.25).

Effect of Type of cutting

Grapevines are very easy to grow from cuttings. It is well known that in comparison to soft wood cuttings, grapes are generally propagated through hardwood cuttings. The main reasons are due to its highest success rate without the use of special rooting technique, least expensive and easiest method of vegetative propagation. Cuttings can also be made from the stem, modified stem, roots or leaves (Karakurt, 2009 and Waite, *et al*. 2015). Significant variations in shoot and root parameters have been observed in hardwood cuttings of grape varieties kept under different propagating structures including open condition (Ravindran *et al*., 2006). Among the various structures, medium cost greenhouse structure with humidifier and fans (S_2) was found to produce cuttings with a higher number (14.61) and length (14.51cm) of roots, a higher percentage of rooting (92%) and a higher percentage of survival (96.68%), while high cost greenhouse structure with misting (S_1) produced a higher number of leaves and sprout length with early sprouting (19.52 days). Hartmann and Kester (1983) stated that best rooting was usually found in cuttings taken from the basal portion of the shoots. This was referred to the possibility of higher accumulation of carbohydrates and concentration of endogenous root- promoting substances that were produced in buds and leaves.

Munoz (1976) carried out an experiment to study the effect of position on the shoot and the period of taking cuttings on two vine species. He found that, dormant basal cuttings of Vitis vinifera cv. Sultamina rooted better than cuttings taken from the central or apical parts of the shoot, with Vitis chompini cv. Dogridge apical cuttings taken in early summer rooted better than cuttings taken in January, February , March, or April cuttings from the basal or central part of the shoot. Daulta (1982) investigated the effect on rooting of cuttings taken from different portions of grape (Vitis vinifera L.). He showed that, in 2 years trials with 4 cvs, that the mean rooting percentage was highest in basal and lowest in apical cuttings. Goode (1983), investigated the rooting of leafy muscadine grape cuttings. Leafy cuttings, were taken at 2 week intervals from 30 May to 7 August. Shoots were divided into basal, middle and terminal selection and were treated with either 0, 3000 or 6000 p.p.m IBA and placed in vermiculite under mist. In late November, the cuttings were evaluated for rooting percentage, root quality and shoot growth. Terminal shoot sections had a lower rooting percentage than the basal and middle sections on the early dates but were similar or better on later dates. Terminal sections with good to fair root quality had less shoot growth than basal and middle sections.

Patil (2001) studied the effect of plant growth regulators on survival and vegetative growth of grape vine cuttings. He used IBA at 100, 200 and 300 ppm; NAA at 100, 200 and 300 ppm; and combination of IBA + NAA at 100 + 100, 200 + 200 and 300 + 300 ppm concentration. The maximum number of sprouts per cutting was obtained with 300 ppm IBA and 300 ppm NAA, while 100 ppm IBA and 100 ppm NAA resulted in the maximum number of leaves per cutting. Combination of the plant regulators IBA and NAA at different levels was detrimental to the vegetative growth of the crop. Among the rooting media, sand + 10% cocopeat found to be the optimum for both hardwood and soft wood cuttings of Dogridge and 1613C rootstocks as it gave higher percentage of rooting and number of roots per cutting (Rao, 2004). The hardwood cuttings presented 100% of sprouted cuttings, but it was not verified rooting, independent of the utilization of plant regulators. The softwood cuttings that were not treated with plant regulators showed 92% of rooting and 84% of sprouting (Botelho *et al*. 2005).

Effect of Rooting media

Rooting of grape cuttings and the subsequent root growth was found to be influenced by the rooting medium. Among the several rooting media, sand is extensively used, as it is easily available and the least expensive. Sand consists of virtually no mineral nutrients and has no buffering capacity. It is mostly used as a single medium or in combination with organic materials (Sadhu, 1986). Singh *et al*. (1971) observed that the soil to be a superior rooting medium in comparison to sand and leaf mould. Similarly, Singh and Singh (1973) also reported soil to be a better medium than sand for rooting of cuttings of Perlette grape. Ferrer *et al*. (1991) reported that percentage rooting was highest in sand (84.9), followed by soil (37.7) and the soil + sand mix (27.8). But the root development in sand was poor and the plants were not commercially acceptable. While the cuttings rooted in soil + sand mix produced better root and shoot development. Kawecki and Kozlowski (1995) studied the effect of nine different organic substrates viz., municipal waste compost, conifer bark, peat, sand, fresh or old conifer sawdust, and hardwood sawdust in different combinations on rooting of one-bud hardwood cuttings of grape cv. Skarb Panoii. They found best rooting after five weeks on a substrate containing 8-year-old sawdust + sand or sand mixed with lowland peat.

Kawai (1996) observed that the disbudding of hardwood cuttings of grape cv. Muscat Bailey A completely inhibited rooting in a vermiculite and perlite medium than in the cuttings having a single bud. Cyrillo *et al*. (1999) observed no difference between two rooting media viz., vermiculite and washed river sand when used for rooting of semihardwood cuttings of the grape rootstocks, 'IAC 313 Tropical' and 'IAC 766 Campinas' in a mist chamber. Lobato *et al*. (2001) reported that there is possibility of using rockwool as an alternative substrate for propagation of grape cvs. Moscatel Rosada and Carmenere and observed that chitosan when combined with rockwool has got plant growth stimulating effect on roots. Song *et al*. (2001) observed sand + vermiculite as best basic substrate for rooting of cuttings in four grape varieties derived from crosses involving *Vitis amuriensis*. Zhuang *et al*. (2001) reported that the seedlings of grape cv. Wanhong obtained through *in vitro* methods when grown in vermiculite were normal, leaf color was green and the root : shoot ratio was optimum. The combination of growing media with vermiculite + perlite (2:1) was also found to be best, while growth at higher levels of perlite was poor with pale leaf colour and poor root growth.

Rao, (2004) reported that the considering the rooting performance and survival percentage, February and March months for hardwood cuttings and March for soft wood cuttings are best months for taking cuttings for the

propagation of Dogridge and 1613C. Ibrahim (2008) showed that sand/ fiber mixture gave a higher percentage of rooting success and produced stronger and more fibrous roots than sand, fiber or peat moss alone. Dvin *et al*. (2011) reported that using of coco peat + perlite media resulted in higher percentage of cuttings that rooted.

Effect of Planting Time

The seasonal variation in temperature, light and relative humidity play a very important role in rooting of cuttings. High air temperature tends to promote bud development in advance of root development and increases water loss from the leaves. In all types of plant growth, light has got prime importance since it is the source of energy for photosynthesis. There are evidences that photoperiod has an influence on the rooting of cuttings. Similarly high relative humidity around the cuttings has an active role in controlling water loss from the leaves. Bhattacharya (1959) observed that the hardwood cuttings of Anab-e-Shahi planted in sand on 6 January gave the best rooting. Similar results were obtained by Bhomi (1966) and Saraswat (1973) in Bhokri and Selection-7 when planted in first week of January. Shisode (1964) observed better rooting from cuttings made from canes of October than April prunings in Phakdi, Bangalore Purple, Thompson Seedless and Selection-7 cultivars. Choudhari and Jindal *et al*. (1989) took cuttings from August pruned vines of cvs. Beauty Seedless and Pusa Seedless and got good rooting percentage. They stated that this method reduced the propagation phase by half as cuttings taken in August were ready for transplanting in February.

Rema and Pandey (1990) studied the effect of seasonal fluctuations in the root density of 18 year old Beauty Seedless grape grown in sandy loam soil of pH 8.3 under Delhi conditions and reported that feeder root density increased from July and recorded two peaks of increased root activity, one in August – October and another in March – April. They observed decline in root growth with decrease in temperature and started increasing again with a rise in temperature. Ferrer *et al*. (1991) in Uruguay, observed no difference in rooting of cuttings of grape rootstock SO4 in mid-June or at the end of August. While, Lin and Wu (1995) reported that the cuttings taken from the secondary shoots of 7-8 year old vines of cv. Ryubo during May-July rooted best when dipped in IBA 1000 ppm for 5 seconds.

Indole butyric acid (IBA) is an organic compound influencing plant growth in many ways including cell enlargement and elongation and root initiation. It is commonly used in tissue culture procedures to initiate roots in explants or callus (Wayne, 2000). Zhang *et al*. (2002) in China studied the effect of date of planting on the rooting of hardwood cuttings of grape varieties Jingxiu and Jingyu and found that planting on 25 February was best which resulted in dark green leaves, many rootlets and normal growth of cuttings than planting on 30 November, 25 December or 25 January. Lin and Wu (1995) reported that the cuttings taken from the secondary shoots of 7-8 year old vines of cv. Ryubo during May-July rooted best when dipped in IBA 1000 ppm for 5 seconds.

Effect of Growing Condition

Mist house condition is often used on cuttings because it reduces the leaves temperature, increases relative humidity and lowers respiration around the leaf surface (Singh, 2018). Intermittent mist is often used on cuttings because it reduces the temperature of the leaves, lowers respiration, and increases relative humidity around the leaf surface as also stated by Langhans, (1955). Prolings and Therios (1976) have also showed that creating humid atmosphere by means of artificial mist around the planted cuttings either in concealed pot culture house or in open conditions has proved to enhance the process of rooting. A fine water spray at frequent intervals reduces the transpiration and brings down the leaf temperature to a lower level, thereby creating a favorable condition for rooting of cutting (Good and Turkey, 1966).

CONCLUSION

Grapes are very easy to grow from cuttings. It is well known that in comparison to soft wood cuttings, grapes are generally propagated through hardwood cuttings. Adventitious rooting and shoot growth are affected by environmental conditions, exogenous and endogenous biochemical compounds, ontogenetic age of plant material, genotype, characteristics of the cuttings i.e. growth conditions of the stock plant, rooting media and treatment of cuttings. Growing media should be considered an essential part of the propagation system because rooting competency depends on the type of medium used. Rooting medium directly effect on quality and percentage of rooting.

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