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Effect of Indole-3-Butyric Acid (IBA) and Different Growing Media on Hardwood Cutting of Grapes (*Vitis vinifera* L.) cv. Pusa Navrang

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ABSTRACT: The present study was conducted at Research Farm, College of Horticulture, Mandsaur, Madhya Pradesh during 2020-21. The experiment was laid out using Factorial RBD with IBA treatments (i.e. 0, 2000, 4000 and 6000 ppm) and different growing media (Soil, sand, Cocopeat, Soil + Sand + FYM, Soil + Sand + Vermicompost) under net house condition in poly bags. The different observations was recorded i.e. Shoot Parameters like shoot length, internodal length, number of buds per shoot, stem fresh weight, stem dry weight. Root Parameters like number of primary and secondary roots, root length, fresh weight of root, dry weight of root. Leaf Parameters like number of leaves per plant, fresh weight of leaf, dry weight of leaf, leaf area index (LAI). The hardwood cuttings when treated with IBA 6000 ppm and planted in Soil + Sand + Vermicompost had recorded significantly highest shoot and root growth in grapes. The best result was found for shoot parameter like shoot length (10.33 cm, 75 cm), number of nodes per shoot (7.71, 21.40), internodal length (3.21 cm,7.18 cm), number of buds per shoot (15.00, 32.55), stem diameter (19.34 mm, 29.32 mm) at 60 and 90 DAP, stem fresh weight (18.21g), stem dry weight (7.98 g) at 90 DAP. Root Parameters like number of primary (24.20, 38.59) and secondary roots (21.09, 32.43), root length (25.49 cm, 30.45 cm), root thickness (1.96 mm and 2.12 mm), whole root volume (22.36 cm^2 and 29.47 cm^2) at 60 and 90 DAP, fresh weight of root (6.93 g), dry weight of root (3.05g) at 90 DAP. Leaf Parameters like number of leaves per plant (13.86, 33.09) at 60 and 90 DAP, fresh weight of leaf (1.81 g), dry weight of leaf (0.86 g), leaf area (77.85 cm^2), leaf area index (4.49), specific leaf weight (31.62 mg $Dw.cm^{-2}$) at 90 DAP, while minimum days taken to emergence of 1st leaf (19.67 DAP) found in soil + sand + vermicompost with IBA @ 6000 ppm (M_5G_3).

Keywords: IBA, Growing Media, Hardwood, Grapes and Pusa Navrang.

INTRODUCTION

Grape (*Vitis vinifera* L.) is one of the most important commercial crop of temperate & tropical world. It is belongs to the family Vitaceae with basic chromosome number, 2n = 38. Native of this crop is Western Asia and Europe. The major grape growing countries in the world are Italy, France and USA (Chakraborty and Rajkumar 2018).

Grapes familiar to India since 11th century B.C., but its antiquity not recognized until end of 12th century. The foreign invaders introduced this crop to our country. Mohamed Bin Tuglak in year 1338 introduced some varieties i.e. Abi (Bhokri), Fakhri and Sahebi in Southern part of India. A French priest in year 1832 at Melapatti, a village near Krishnagiri (Charmapuri-District) Tamil Nadu introduced the grape (Shanmugavelu, 1989).

In India about 75% ripe fruits are consumed as fresh. The grape berries are naturally fortified calcium, phosphorus, iron and Vitamin B_1, B_2 and C. Major Sugars present in grapes are Dextrose (glucose) and levulose (fructose). Different varieties possess different TSS ranging from 12 to 18°Brix (Bal, 2006).

The Major grapes growing countries are France, Italy, Spain and USA. In India grape is mostly use for fresh consumption and the mostly grape growing states of our countries are Maharashtra, Tamil Nadu, Karnataka, Madhya Pradesh, Punjab & Haryana with 139 thousand ha with production of 2920 MT and productivity of 11.1 t/ha (Horticulture statistics at A glance 2018). Madhya Pradesh has non-traditional area of grape cultivation with total area under grape cultivation is 0.09 thousand ha with production of 1.28 MT and productivity of 15 t/ha (Anonymous, 2018).

Propagation through seeds is time consuming method as well as it produces genetically variable and more vigorous plants, which bear late. While propagation of plants through cuttings (vegetative) is easier, less time consuming, true to type and bear early with less vigor (Damar *et al*., 2014).

MATERIAL AND METHODS

The experiment was conducted at Research Farm, College of Horticulture, RVSKVV, Mandsaur (M.P.) during the year 2020-21. Mandsaur is situated in plateau in Western part of Madhya Pradesh at North latitude of 23.450 to 24.130 and 74.440 to 75.180 East longitudes and an altitude of 435.02 meters above mean sea level. This region falls under Agro Climate No. 10 of the state. Cuttings of grape (*Vitis vinifera* L. var. Pusa Navrang) were obtained from the orchard of grapes from farm of college of Horticulture Mandsaur (M.P.). The plants are five years old. Selection of branches from these plants as experimental material was based on their uniformity in appearance, growth habit and vigor. Terminal, medium and basal cuttings were taken from one year old branches.

Filling of poly bags: Before the cutting planting the 5 × 7 inch poly bags will be filled with different growing media. Three hundred sixty (360) poly bags of each growing media should be filled i.e., 630 bags of Soil, 360 bags of Soil + Sand (1:1 ratio), 360 bags of Soil + Sand + FYM (1:1:1 ratio) and 600 bags of Soil + Sand + Vermicompost (1:1:1 ratio).

Preparation of cutting: After the filling of growing media in poly bags, the hard wood cuttings of uniform size having 4-5 functional bud will be taken from healthy plants of Grapes variety Pusa Navrang from one year matured shoots planted at the grapes orchard at research farm, College of Horticulture, Mandsaur.

Preparation of hormonal solution: The weighing of IBA will be done with the help of electronic balance. The requisite quantity 2g, 4g and 6g (2000 ppm, 4000 ppm and 6000 ppm) will weighed separately and transferred in to flask and then initially the IBA sample will dissolve in 10 ml ethyl alcohol (90%) and make the volume 1000 ml with mixing 990 ml distil water. By this process we will find the 2000, 4000 and 6000 ppm IBA solution.

Application of growth regulators: The fresh basal end cut of the cutting about 2.5 cm will be dipped in proposed hormonal solution for about 5 second and then after we will let in shad, so that the cutting could absorb the hormone and best result should be obtained. After this process the cutting will planted in poly bags.

Planting: The cutting about 0.75 to 1 cm thick diameter will be taken and planted in poly begs with 2-3 functional buds below the ground. Before the planting the hole should be done from planting place with the help of stick for preventing the buds to injuries.

A. Observations noted

The observations were recorded on shoot, root and leaf parameters these are as follows.

A. Shoot Parameters

1. Shoot length (cm): This observation is recorded at a fixed interval of 30 days i.e. 30, 60, 90 Days after planting. The longest shoot was measured with the help of meter scale on each selected cutting and then mean length of shoot were calculated. It was expressed in centimetres.

2. Number of nodes per shoot: The numbers of nodes per shoot were counted on selected cutting and the mean number of nodes per shoot was calculated.

3. Inter-nodal length (cm): Inter-nodal length is length between two nodes. This observation was recorded 30, 60, 90 days after planting. Inter-nodal length is measured by meter scale from selected cutting then mean of inter-nodal length were calculated. It was expressed in centimetre.

4. Internodal length (cm): Internodal length is measured by meter scale from selected cutting then mean of inter-nodal length were calculated. It was expressed in centimetre.

5. Stem Diameter (mm): Stem diameter is calculated by the help of vernier caliper from selected cuttings and then mean stem diameter were calculated. It was expressed in millimetre.

6. Stem fresh weight (g): Fresh weight of stem without roots of each selected cutting was estimated by electric physical balance. Stem fresh weight was expressed in grams.

7. Stem dry weight (mg): Dry weighed stem of each selected cutting were oven dried at 60°C. The stem were transferred quickly to desiccators and allowed to attain room temperature. The dried stem was weighed. The process of heating and cooling was repeated until constant weight was obtained. It was expressed in gram.

B. Root Parameters

1. Number of primary roots: Roots were separated from cutting with the help of a sharp blade and primary roots were counted on each selected cuttings, then mean number of primary roots per cutting was calculated.

2. Number of secondary roots: Roots were separated from cutting with the help of a sharp blade and number of roots which are attached to primary roots were counted on each selected cuttings, the mean number of secondary roots per cutting was calculated.

3. Root length (cm): The longest roots of each selected cutting were measured with help of meter scale and then mean length of roots was calculated. It was expressed in centimetre.

4. Root thickness: The root thickness of longest root of each selected cutting was measured with the help of screw gauge and then the average thickness was calculated. It was expressed in millimetre.

5. Whole root volume: Root volume can be calculated by measuring the average root diameter and the root length. Such calculations, however, have seldom been done in practice (Bhaskaran and Chakrabarty 1965). It was expressed in centimetre sq. (cm^2).

6. Root fresh weight (g): This observation was recorded after separation of roots from sample cutting with the help of a sharp blade and fresh weight was estimated by electric physical balance. It was expressed in gram.

7. Root dry weight (g): Dry weight of roots was estimated by means of electric physical balance and it was expressed in gram.

C. Leaf Parameters

1. Days taken to emergence of 1st leaf: After planting of cutting as per treatments, the experimental site was visited daily and all the cuttings under the experiments were observed critically and the date of few cutting (1-5) sprouted in a particular treatment was noted. There after the days taken for sprouting after planting was calculated with the difference between date of planting of cuttings and the date on which the cutting were sprouted.

2. Number of leaves per plant: The numbers of leaves were counted on each selected cuttings and then mean number of leaves per plant was calculated.

3. Fresh weight of leaves (g): Fresh weight of leaves of each selected cutting was estimated by electric physical balance. It was expressed in gram.

4. Dry weight per leaf (mg): Fresh weighed leaves of each selected cutting were oven dried at 60°C. The leaves were transferred quickly to desiccators and allowed to attain room temperature. The dried leaves were weighed. The process of heating and cooling was repeated until constant weight was obtained. It was expressed in gram.

5. Leaf area: Five leaves were randomly selected from each selected cutting than length and width of each selected leaf was measured with the help of meter scale and area of leaf was calculated. Then, mean leaf area was calculated. It was expressed in centimetre sq. (cm^2).

6. Leaf area index: Leaf area index is ratio between leaf area and ground area and is estimated as below (Watson, 1952)

$$LAI = \frac{A}{P}$$

Where, A = Leaf area (in cm^2)

P = Ground area (in cm^2)

7. Specific leaf weight ($mgDW.cm^{-2}$): Specific leaf weight is ratio between dry weight of leaves and total leaf area and it is estimated as below:

$$SLW = DWL / LA$$

Where, DWL = Dry weight of leaves

LA = Total leaf area

RESULTS AND DISCUSSION

A. Shoot Parameters

Shoot length. The data (Table 1) revealed that, the shoot length of cuttings recorded significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm *i.e.*, 10.33 cm, 75 cm in hard wood cuttings at 60 and 90 DAP, respectively. Minimum shoot length was recorded in treatment M_1G_0 (soil) with IBA 0 ppm *i.e.*, 2.87 cm, 6.00 cm at 60 and 90 DAP respectively. This is due to increase in growth- promoting substances, the buildup of photosynthates metabolites and improved water absorption in treatment M_5G_3 (soil + sand + vermicompost) in 1:1:1 ratio with IBA @ 6000 ppm. Panchal *et al*. (2014) Soni, *et al*. (2015); Soni *et al*. (2016) in guava, Manila *et al*. (2017) in pomegranate, Padekar *et al*. (2018) in Kartoli also obtained similar findings.

Number of nodes per shoot. Treatment soil + sand + vermicompost @ 6000 ppm (M_5G_3) (7.71, 21.40) had the most nodes per shoot, and treatment M_1G_0 (soil with control IBA treatment) found least number of nodes per shoot i.e., 3.22, 5.29 at 60 and 90 DAP respectively. This might due to the growth of longer sprouts, which increases meristematic activity and improved performance. These findings backed up by other research. Barde *et al*. (2010) in pomegranate, Kumawat *et al*. (2010) in pomegranate, Abouzar Abouzari *et al*. (2012); Akshay *et al*. (2014); Padekar *et al*. (2018).

Internodal length. The data (Table 1) revealed that, the internodal length of cuttings recorded significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 3.21 cm,7.18 cm in hard wood cuttings at 60 and 90 DAP, respectively. Minimum internodal length was recorded in treatment M_1G_0 (soil) with IBA 0 ppm *i.e.*,0.99 cm, 1.31 cm at 60 and 90 DAP respectively. It could be due to the availability of a large amount of stored carbohydrate, which aided the rapid growth. Similar results found by Somkumar *et al*. (2009) in grapes, Chakraborty and Rajkumar (2018) in grapes.

Stem diameter. Highest stem diameter found with soil + sand + vermicompost with IBA @ 6000 ppm (M_5G_3) i.e., 19.34 mm, 29.32 mm and the treatment M_1G_0 (soil with 0 ppm IBA) i.e., 8.32 mm, 16.88 mm had the minimum stem diameter respectively at 60 and 90 DAP. It might be due to the use of FYM and vermicompost to improve the use of stored carbohydrates, nitrogen, and other variables, Siddiqua *et al*. (2008) in dragon fruit, Singh (2013) in Citrus limon and Kaur Sukhjit (2017) in Flordaguard peach also recorded these results.

Number of buds per shoot. The data (Table 1) revealed that, the number of buds per shoot recorded significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 15.00, 32.55 in hard wood cuttings at 60 and 90 DAP, respectively. Minimum number of buds per shoot was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e., 4.19, 5.17 at 60 and 90 DAP respectively. Auxin treatments accelerate the hydrolysis of nutritional reserves and their mobilization of sprouting, Chakraborty and Rajkumar (2018) in grapes. This was in line with the conclusions of Singh *et al*. (2015) in lemon. This might be because of external application of auxins promotes growth and produce more favorable conditions for sprouting of dormant buds on the cutting Tanwar *et al*. (2020) in pomegranate.

Stem Fresh weight. The data (Table 1) revealed that, the stem fresh weight recorded significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 18.21g in hard wood cuttings at 90 DAP. Minimum stem fresh weight was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e., 4.99 g at 90 DAP. This might be because of adding vermicompost to other medium enhances the water holding capacity, nutrient retention that is important for plant development in the early stages, Tanwar *et al*., (2020) in pomegranate. Present findings are in conformity with the findings by Dahale *et al*., (2018) in Fig and Singh (2017) in pomegranate.

Table 1: Effect of IBA and Different Growing Media on Hardwood Cutting of Grapes for shoot parameters.

Treatments	Shoot length (cm)		Number of nodes per shoot		Internodal length (cm)		Stem diameter (mm)		Number of buds per shoot		Stem fresh weight (g)	Stem dry weight (g)
	At 60 DAP	At 90 DAP	At 60 DAP	At 90 DAP	At 60 DAP	At 90 DAP	At 60 DAP	At 90 DAP	At 60 DAP	At 90 DAP	At 90 DAP	At 90 DAP
M1G0	2.87	6.00	3.22	5.29	0.99	1.31	8.32	16.88	4.19	5.17	4.99	1.56
M1G1	3.20	18.50	4.57	8.07	1.40	3.10	9.19	20.22	5.00	11.97	8.39	3.12
M1G2	4.30	33.20	5.52	12.10	2.12	4.83	12.17	21.47	6.69	21.65	12.79	4.97
M1G3	4.80	34.50	6.43	12.62	2.23	5.20	12.60	21.98	8.17	22.23	12.89	5.08
M2G0	2.60	10.00	3.38	5.68	1.06	1.48	8.53	16.90	4.44	8.88	4.99	1.58
M2G1	3.21	23.90	4.77	8.25	1.52	3.32	9.66	19.42	5.32	14.58	8.99	3.36
M2G2	5.43	38.40	6.53	13.64	2.33	5.41	14.12	23.22	8.68	22.98	13.69	5.49
M2G3	6.23	42.80	6.71	14.16	2.42	5.58	14.44	23.80	9.37	23.27	15.09	6.13
M3G0	2.71	12.40	3.68	6.01	1.16	1.88	8.65	17.27	4.59	9.05	5.39	1.74
M3G1	3.47	24.10	5.02	8.98	1.60	3.90	9.92	19.62	5.67	18.88	10.89	4.11
M3G2	7.23	46.80	6.94	15.01	2.63	5.92	16.32	25.27	10.00	24.17	16.59	6.86
M3G3	7.83	52.40	7.12	15.52	2.71	5.95	16.77	25.76	10.72	24.45	16.69	6.98
M4G0	2.88	13.60	3.83	6.30	1.30	2.18	8.82	17.67	4.82	9.58	5.99	1.83
M4G1	3.61	28.30	5.36	9.38	1.72	3.99	10.19	20.03	6.01	19.27	11.63	4.42
M4G2	8.26	58.50	7.29	17.22	2.80	6.51	18.26	27.02	12.34	26.58	17.00	7.20
M4G3	8.80	64.60	7.43	18.26	2.82	6.63	18.73	27.70	13.49	30.41	17.59	7.55
M5G0	2.95	17.50	3.89	6.93	1.33	2.72	7.60	17.92	4.90	10.88	6.99	2.31
M5G1	4.22	31.60	5.70	10.30	1.81	4.70	10.53	20.66	6.34	19.98	11.99	4.63
M5G2	9.52	68.50	7.63	20.36	2.92	6.83	19.12	28.90	14.42	31.49	17.97	7.81
M5G3	10.33	75.00	7.71	21.40	3.21	7.18	19.37	29.32	15.00	32.52	18.21	7.98
S.Em±	**0.22**	**1.21**	**0.17**	**0.48**	**0.08**	**0.12**	**0.69**	**0.93**	**0.44**	**0.96**	**0.50**	**0.25**
CD (%)	**0.62**	**3.45**	**0.48**	**1.37**	**0.23**	**0.33**	**1.97**	**2.66**	**1.27**	**2.75**	**1.43**	**0.72**

Stem dry weight. The data (Table 1) revealed that, the stem dry weight recorded significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 7.98g in hard wood cuttings at 90 DAP. Minimum stem dry weight was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e., 1.56 g at 90 DAP. This could explain by the fact that auxins increased cell permeability to moisture and nutrients, resulting in cell enlargement and increased plant growth. They increased the number of shoots resulting in higher fresh and dry weight of shoots, Kaur *et al*. (2017) in Flordaguard peach. Similar findings were also reported by Panchal *et al*. (2014). This might be because adding vermicompost to other medium enhances water holding capacity and nutrient retention, both of which are important in the early stages of plant growth. Tanwar *et al*., (2020) in pomegranate. Present findings are in conformity with the findings by Dahale *et al.*, (2018) in Fig and Singh (2017) in pomegranate.

B. Root Parameters

Number of primary and secondary roots. The data (Table 2) revealed that, number of primary roots significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 24.20, 38.59 in hard wood cuttings at 60 and 90 DAP. Minimum number of primary roots was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e., 10.40 and 14.74 at 60 and 90 DAP respectively.

The data (Table 1) revealed that, number of secondary roots significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 21.09, 32.43 in hard wood cuttings at 60 and 90 DAP. Minimum number of secondary roots was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e., 10.40 and 14.74 at 60 and 90 DAP respectively. It may because of increased levels of growth-promoting substances, build up of photosynthates metabolites and improved water absorption. These findings are in agreement with the findings of Galavi *et al*. (2013) in grapes, Soni *et al*. (2015); Soni *et al.* (2016) in guava, Burman *et al*. (2016) in grapes, Padekar *et al*. (2018) in kartoli, Tanwar *et al*. (2020) in pomegranate.

Root length. The data (Table 2) revealed that, root length were significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 25.49cm, 30.45 cm in hard wood cuttings at 60 and 90 DAP. Minimum number of primary roots was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e., 7.00 cm, 8.12 cm at 60 and 90 DAP respectively. Increased levels of growth-promoting substances, build up of photosynthates metabolites and improved water absorption can all linked to this. Similar findings were also reported by Galavi *et al*. (2013) in grape, Panchal *et al*. (2014); Burman *et al*. (2016) in grapes, Padekar *et al*. (2018) in kartoli.

Root thickness. Highest root thickness was found in case of treatment soil + sand + vermicompost with IBA @ 6000 ppm (M_5G_3) i.e., 1.96 mm and 2.12 mm. Though, the lowest root thickness was observed in treatment soil with control (M_1G_0) i.e., 1.58 mm and 1.68 mm at 60 and 90 days after planting, respectively. This can be attributed due to increased level of growth promoting substance, accumulation of photosynthates metabolites and better water absorption. These findings are in agreement with the findings of Abdul Nasir and Wani (2014); Mohsen *et al*. (2015) in Kiwifruit, Burman *et al*. (2016) in grapes.

Whole root volume. Highest whole root volume per cutting was assessed in treatment soil + sand +

vermicompost with IBA @ 6000 ppm (M_5G_3) i.e., 22.36 cm^2 and 29.47 cm^2. Lowest whole root volume per cutting observed in treatment soil with IBA @ 0 ppm (M_1G_0) i.e., 7.34 cm^2 and 9.65 cm^2 at 60 and 90 days after planting, respectively. This can be attributed due to increased level of growth promoting substance, accumulation of photosynthates metabolites and better water absorption. Similar results also reported by Singh and Tomar (2015); Singh (2015) in Phalsa, Rolaniya *et al*. (2018) in grapes, Siddiqua *et al*. (2018) in dragon fruit, Rajamanickam and Balamohan (2019) in pomegranate.

Fresh weight of root. The data (Table 2) revealed that, the fresh weight of root recorded significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 6.93g in hard wood cuttings at 90 DAP. Minimum fresh weight of root was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e., 2.02 g at 90 DAP. This can be attributed due to increased level of growth promoting substance, accumulation of photosynthates metabolites and better water absorption. Similar findings were also reported by Saffari and Saffari (2012) in hop bush, Galavi *et al*. (2013) in grapes, Abdul Nasir and Wani (2014); Mohsen *et al*. (2015) in kiwifruit, Burman *et al*. (2016) in grapes, Tanwar *et al*. (2020) in pomegranate.

Dry weight of root. The data (Table 2) revealed that, the stem dry weight recorded significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 3.05g in hard wood cuttings at 90 DAP. Minimum dry weight of root was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e., 0.64 g at 90 DAP. Increased levels of growth promoting substances, build up of photosynthates metabolites and improved water absorption which increases dry weight of roots. Galavi *et al*. (2013) in grapes, Hammo *et al*. (2013), Abdul Nasir and Wani (2014); Panchal *et al.* (2014); Mohsen *et al*. (2015) in kiwifruit, Burman *et al.* (2016) in grapes also reported similar findings.

C. Leaf Parameters

Days taken to emergence of 1st leaf. Treatment M_5G_3 (soil + sand + vermicompost IBA @ 6000 ppm) found minimum number of days to emergence of 1st leaf after planting i.e., 19.67. While the maximum number of days taken by treatment M_1G_0 (27.67) after 90 days after planting. This can be attributed due to increased level of growth promoting substance, accumulation of photosynthates metabolites and better water absorption in vermicompost and FYM. Similar result observed by Hammo *et al*. (2013); Tanwar *et al*. (2020) in pomegranate.

Table 2: Effect of IBA and Different Growing Media on Hardwood Cutting of Grapes for root parameters.

Treatments	Number of Primary roots		Number of Secondary roots		Root length (cm)		Root thickness (mm)		Whole root volume		Fresh weight of root (g)	Dry weight of root (g)
	At 60 DAP	At 90 DAP	At 60 DAP	At 90 DAP	At 60 DAP	At 90 DAP	At 60 DAP	At 90 DAP	At 60 DAP	At 90 DAP	At 90 DAP	At 90 DAP
M1G0	10.40	14.74	4.99	14.75	7.00	8.12	1.58	1.68	7.34	9.65	2.02	0.64
M1G1	15.60	18.29	8.32	17.57	9.31	10.38	1.66	1.76	10.78	13.68	3.14	1.17
M1G2	19.18	22.43	12.78	22.43	14.88	15.17	1.73	1.85	14.85	18.65	4.16	1.63
M1G3	20.60	22.93	12.89	23.53	15.45	15.58	1.74	1.86	15.55	19.46	4.42	1.76
M2G0	11.07	15.23	4.99	15.26	7.67	8.32	1.59	1.70	7.89	9.87	2.30	0.74
M2G1	16.58	19.38	8.99	18.17	10.48	11.11	1.68	1.78	10.96	14.41	3.47	1.31
M2G2	21.05	23.60	13.69	24.34	16.09	16.00	1.78	1.90	15.72	21.72	4.71	1.91
M2G3	21.20	23.94	15.08	25.62	17.65	17.69	1.78	1.91	16.20	22.22	4.99	2.04
M3G0	12.25	15.84	5.39	15.93	7.97	8.58	1.61	1.70	8.96	9.95	2.51	0.81
M3G1	17.14	20.25	10.89	18.68	11.01	11.48	1.69	1.78	12.78	16.37	3.61	1.37
M3G2	22.58	25.64	16.59	27.44	19.07	20.58	1.83	1.96	17.57	23.81	5.39	2.24
M3G3	22.93	27.43	16.68	28.18	20.79	21.38	1.85	1.97	18.31	24.88	5.73	2.42
M4G0	12.87	16.19	5.99	16.56	8.04	8.83	1.62	1.74	9.33	10.09	2.76	0.90
M4G1	18.43	21.40	11.58	19.73	14.20	11.71	1.71	1.82	12.86	16.61	3.81	1.46
M4G2	23.29	28.24	16.99	29.37	22.07	23.99	1.91	2.02	19.16	26.74	6.06	2.59
M4G3	23.75	30.51	17.59	30.34	23.43	24.19	1.93	2.05	20.38	27.41	6.43	2.80
M5G0	13.58	17.17	6.99	16.96	8.27	8.93	1.64	1.76	9.89	11.27	2.95	0.99
M5G1	18.65	21.80	12.01	20.80	14.20	12.11	1.71	1.84	13.85	17.34	3.97	1.55
M5G2	24.00	34.92	18.89	31.28	23.98	27.25	1.94	2.08	21.77	28.79	6.74	2.95
M5G3	24.20	38.59	21.09	32.43	25.49	30.45	1.96	2.12	22.36	29.47	6.93	3.05
S.Em±	**0.15**	**1.19**	**0.63**	**0.95**	**0.68**	**0.80**	**0.03**	**0.03**	**0.65**	**0.89**	**0.24**	**0.09**
CD (%)	**0.43**	**3.40**	**1.80**	**2.71**	**1.95**	**2.29**	**0.08**	**0.08**	**1.86**	**2.54**	**0.67**	**0.25**

Number of leaves per plant. The data (Table 3) revealed that, number leaves per plant were significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 13.86, 33.09 in hard wood cuttings at 60 and 90 DAP. Minimum number of primary roots was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e., 2.76, 8.31 at 60 and 90 DAP respectively. This can be attributed due to increased level of growth promoting substance, accumulation of photosynthates metabolites and better water absorption. The findings were supported by Soni *et al.* (2015); Soni *et al*. (2016) in guava, Tanwar *et al.* (2020) in pomegranate.

Fresh weight of leaf. The data (Table 3) revealed that, the fresh weight of leaf was recorded significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 1.81g in hard wood cuttings at 90 DAP. Minimum fresh weight of leaf was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e., 0.76 g at 90 DAP. This might be explain by an increase in growth promoting compounds, the build up of photosynthates metabolites and improved water absorption. Abdul Nasir and Wani (2014); Burman *et al*. (2016) in grapes, also reported similar findings.

Dry weight of leaf. The data (Table 3) revealed that, the dry weight of leaf was recorded significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 0.86g in hard wood cuttings at 90 DAP. Minimum dry weight of leaf was recorded in treatment M_1G_0 (soil) with IBA 0 ppm i.e.,0.24 g at 90 DAP. An increase in growth promoting chemicals, the accumulation of photosynthates metabolites and increased water absorption might all increases fresh & dry weight of leaves. Hammo *et al*. (2013); Abdul Nasir and Wani (2014); Panchal *et al*. (2014); Burman *et al*. (2016) in grapes found similar findings.

Leaf Area. Maximum leaf area was found with soil + sand + vermicompost IBA @ 6000 ppm (M_5G_3) i.e., 77.85 cm^2. While, the minimum leaf area observed with soil with IBA @ 0 ppm (M_1G_0) i.e., 10.21 cm^2 at 90 days after planting. Same results found by Burman *et al*. (2016) in grapes.

Leaf Area Index (LAI). The data (Table 3) revealed that, the leaf area index was recorded significantly highest with M_5G_3 (soil + sand + vermicompost) with IBA @ 6000 ppm i.e., 4.49 in hard wood cuttings at 90 DAP. Minimum leaf area index was recorded in treatment M_1G_0(soil) with IBA 0 ppm i.e., 2.09 at 90 DAP. Similar results were found by Kushida and Yoshino (2010); Abdul Nasir and Wani (2014); Panchal *et al*. (2014); Burman *et al*. (2016) in grapes.

Specific leaf weight (mgDW.cm^{-2}). Maximum specific leaf weight was observed in soil + sand + vermicompost with IBA @ 6000 ppm (M_5G_3) i.e., 31.62 mgDw.cm^{-2}. While the minimum specific leaf weight recorded in soil with control IBA treatment (M_1G_0) i.e., 9.11 mgDw.cm^{-2} at 90 DAP.

Table 3: Effect of IBA and Different Growing Media on Hardwood Cutting of Grapes for leaf parameters.

Treatments	Days taken to emergence of 1st leaf	Number of leaves/plant		Fresh weight of leaf (g)	Dry weight of leaf (g)	Leaf area (cm^2)	Leaf Area Index
		At 60 DAP	At 90 DAP	At 90 DAP	At 90 DAP	10.21	At 90 DAP
M1G0	27.67	2.76	8.31	0.76	0.24	21.61	2.09
M1G1	26.00	6.36	10.65	1.26	0.49	37.82	2.79
M1G2	25.33	7.35	16.88	1.33	0.50	43.52	3.21
M1G3	25.00	7.68	17.71	1.37	0.53	10.50	3.58
M2G0	27.33	3.02	8.48	0.81	0.26	23.97	2.24
M2G1	25.67	6.71	10.78	1.27	0.49	62.68	2.90
M2G2	24.33	7.90	18.82	1.45	0.59	63.81	3.58
M2G3	24.00	8.17	19.97	1.49	0.61	10.82	3.69
M3G0	27.00	4.42	8.65	0.93	0.29	24.46	2.36
M3G1	25.67	7.02	11.48	1.27	0.48	65.48	2.95
M3G2	22.67	8.58	24.31	1.53	0.63	68.37	3.89
M3G3	21.67	9.66	26.57	1.59	0.69	11.18	3.99
M4G0	26.67	4.67	9.07	1.05	0.35	29.51	2.41
M4G1	25.67	7.19	12.01	1.29	0.49	71.61	3.05
M4G2	21.00	10.02	28.73	1.61	0.71	73.40	4.10
M4G3	20.67	10.63	31.39	1.67	0.73	12.18	4.20
M5G0	26.33	5.06	9.45	1.19	0.39	31.36	2.54
M5G1	25.33	7.34	13.74	1.30	0.48	75.43	3.05
M5G2	20.33	12.69	32.52	1.72	0.79	77.85	4.36
M5G3	19.67	13.86	33.09	1.81	0.86	10.21	4.49
S.Em±	**0.74**	**0.35**	**0.93**	**0.05**	**0.04**	**1.81**	**0.12**
CD (%)	**2.11**	**1.02**	**2.66**	**0.14**	**0.10**	**5.17**	**0.34**

CONCLUSIONS

The study concludes that production of guava plants in net house condition proved to be the best for rapid and cheapest method multiplication of grapes true-to-type plants. The application of growing media soil + sand + vermicompost 1:1:1 along with IBA 6000 ppm was observed significantly superior for growth (rooting and shooting characteristics) in hard wood cutting of grapes. The plants produced by this technique will be true-to-type. These plants will bear earlier than the seedlings. The unique characters of a variety can be preserved through this technique. The technique was developed in this study is simpler, rapid, less labour intensive and economical, as root promoting hormones are required for root initiation. It is useful as compared to conventional method of propagation (grafting/budding) of grapes because of higher success rate, independence of season and climate, small size of cuttings, use of juvenile shoot cuttings, disease free nature and production of large number of uniform true to mother type plants in a short period of time.

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REFERENCES

Abdul, N. and Majid, W. (2014). Estimation of correlation coefficient and effect of different growth regulators and potting media on survival and growth parameters of G 48 poplar clone. *International Journal of Farm Sciences*, *4*(2), 121-129.

Abouzar, A., Sedigheh, R., Alireza, E. and Behzad, K. (2012). Comparison of the Effect of Different Soilless Growing Media on some Growth Characteristics of Benjamin Tree (*Ficus benjamina*). *International Journal of Agriculture & Biology*, *14*(6), 985–988.

Akshay, K. R., Narayana Swamy, Anjali, K. B. and Sreekanth, H. S. (2014). Efficacy of media and growth regulators on biochemical components of black pepper (*Piper nigrum*) cuttings. *Plant Archives*, *14*(1), 59-63.

Anonymous (2018). Horticulture statistics at a glance. Ministry of Agriculture & Farmers Welfare, New Delhi pp. 148&192.

Bal, J. S. (2006). Fruit growing. Kalyani publishers. pp.206.

Barde, P., Tiwari, R., Kanpure, R. N., Baghel, B. S. and Kumawat, B. R. (2010). Effect of biofertilizers and growth regulators on rooting and growth of Pomegranate cuttings. *Ann. Pl. soil Res*., *12*(1), 46-47.

Bhaskaran, A. R., Chakrabarty, D. C. (1965). A preliminary study on the variations in the soil binding capacity of some grass roots. *Indian J. Agron*., *10*, 326-330.

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

Chakraborty, S. and 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*, *09*(07), 8418-8421.

Dahale, M., Ningot, E. P. and Deepa, N. M. (2018). Effect of plant growth regulators on rooting and survival of hardwood cuttings in fig. *International journal of current microbiology and applied sciences, 6*, 2386-2391.

Damar, D., Barholia, A. K., Lekhi, R. and Haldar, A. (2014). Effect of growth regulators and biofertilizers on survival of pomegranate (*Punica granatum* L.) Stem cuttings. *Plant Archives*, *14***(**1), 347-350.

Galavi, M., Karimian, M. A., and Mousavi, S. R. (2013). Effect of different auxin (IBA) concentrations and planting-beds on rooting Grape cuttings (*Vitis vinifera* L.). *Annual Review & Research in Biology*, *3*(4), 517-523.

Hammo, Y. H., Kareem, B. Z. A. and Salih, M. I. (2013). Effect of planting media and IBA concentration on rotting ability of stem cutting of *Ligustrum ovalifolium*. Zanco. *Journal of Pure and Applied Sciences, 27*(5), 63-68.

Kaur, Sukhjit (2017). Evaluation of different doses of indole-3-butyric acid (IBA) on the rooting, survival and vegetative growth performance of hardwood cuttings of Flordaguard peach (*Prunus persica* L. Batch). *Journal of Applied and Natural Science*, *9*(1), 173-180.

Kumawat, B. R., Kanpure, R. N., Tiwari, R., Baghel, B. S. and Barde, P. K. (2010). Rooting and growth of Pomegranate cuttings as influenced by environmental conditions and growth regulator. *Ann. Pl. Soil Res*., *12*(1), 30-31.

Kushida, K. and Yoshino, K. (2010). Estimation of LAI and FAPAR by constraining the leaf and soil spectral characteristics in a radiative transfer model. *International Journal of Remote Sensing*, *31*(9/10), 2351-2375.

Manila, Tanuja, Rana, D. K. and Naithani, D. C. (2017). Effect of different growing media on vegetative growth and rooting in pomegranate (*Punica granatum* L.) Cv. "kandhari" hardwood stem cutting under mist. *Plant Archives*, *17***(**1), 391-394.

Mohsen, S., Nargesi, M., Shahram and Sedaghathoor (2015). Study on rooting of kiwi fruit cultivars (*Actinidia chinensis*) in different substrates and rooting hormones. *South Western Journal of Horticulture, Biology and Environment*, *6*(1), 33-42.

Padekar, V. J., Garande, V. K., Dodake, S. S., Sawant, S. V., Shinde, U. S., Sonawane, P. N., Pawar, R. D. and Dhumal, S. S. (2018). Effect of IBA, types of Cutting and Rooting Media on Sprouting, Survival Percentage and Growth of Cuttings of Kartoli* (*Momordica dioica* Roxb.). *Int. J. Curr. Microbiol. App. Sci.*, *7*(10), 1246-1260.

Panchal, G. P., Parasana, J. S., Patel, S. R. and Patel, M. V. (2014). Effect of different growing Media and levels IBA on growth and development of Khirni (*Manilkara hexandra* Roxb) seedlings cv. local. *Global Journal of Bio-Science and Biotechnology*, *3*(4), 379-383.

Rajamanickam, C. and Balamohan, T. N. (2019). Effect of IBA on rooting of pomegranate (*Punica granatum*) stem cuttings cv. Bhagwa. *International Journal of Chemical Studies*, *7*(5), 218-220.

Rolaniya, M. K., Bairwa, M., Khushbu and Sarvanan, S. (2018). Effect of plant growth regulators (IIA, IBA, and GA_3) on rooting of hardwood cutting of Grape (*Vitis venifera* L.) cv. Thompson Seedless. *Journal of Pharmacognosy and Phytochemistry*, *1*, 398-400.

Saffari, M. and Saffari, V. R. (2012). Effects of media and indole butyric acid (IBA) concentrations on hopbush (*Dodoneae viscosa* L.) cuttings in green house. *Annals of Forest Research*, *55*(1), 61-68.

Shanmugavelu, K. G. (1989). Vit culture in India. *Agro-Botanical Publ.* Bikaner, 84-90.

Siddiqua, A., Thippesha, D., Shivakumar, B. S., Adivappar, N. and Ganapathi M. (2018). Effect of growth regulators on rooting and shooting of stem cuttings in dragon fruit [*Hylocereus undatus* (Haworth) Britton & Rose]. *Journal of Pharmacognosy and Phytochemistry*, *7*(5), 1595-1598.

Singh, K. K. (2017). Vegetative Propagation of Pomegranate (*Punica granatum* L.) through Cutting- *A Review. Int. J. Curr. Microbiol. App. Sci.*, *6*(10), 4887-4893.

Singh, K. K. and Tomar, Y. K. (2015). Effect of planting time and Indole butyric acid levels on rooting of woody cuttings of Phalsa (*Grewia asiatica* L.). *Horti Flora Res Spectrum*, *4*, 39-43.

Singh, K. K., Choudhary, T. and Kumar, P. (2013). Effect of IBA concentrations on growth and rooting of *Citrus limon* cv. Pant Lemon cuttings. *Biol. sci. Agric. Advancement Soc*., *2*(3), 268-270.

Singh, V. P., Mishra, D. S. and Ratna, R. (2015). Effect of growing season, PGRs and rooting media on survival of hard wood stem cuttings of lemon (*Citrus limon*) cv. Pant lemon-1. *Hort. Flora Res Spectrum*, *4*, 347-350.

Somkumar, R. G., Satisha, J., Ramtekeand, S. D. and Sharma, J. (2009). Root distribution, Partitioning of dry matter and nutrient uptake in Thompson seedless grapes (*Vitis vinifera* L.) grafted on different rootstocks. *India. J. Agril. Sci*., *79*, 669-673.

Soni, N., Pandey, S. K., Singh, S. S., Singh, S. R. K., Mishra, A., Baghel, S. S. and Kaurav, P. K. (2015). Propagation of guava through cuttage under net house condition at Jabalpur, Madhya Pradesh, India. *Int. Jr. App. and Pure Sc. and Agr.*, *1*(12), 131-136.

Soni, N., Pandey, S. K., Singh, S. S., Singh, S. R. K., Mishra, A., Baghel, S. S. and Kaurav, P. K. (2015). Production of true-to-type guava plants through clonal propagation. *Flora and Fauna.*, *22*(1), 36-40.

Shanmugavelu, K. G. (1989). Vit culture in India. *Agro-Botanical Publ.* Bikaner, 84-90.

Tanwar, D. R., Bairwa, H. L., Lakhawat, S. S., Mahawer, L. N., Jat, R. K. and Choudhary, R. C. (2020). Effect of IBA and rooting media on hardwood cuttings of Pomegranate (*Punica granatum* L.) CV. Bhagwa. *International Journal of Environment and Climate Change*, *10*(12), 609-617.

Watson, D. J. (1952). Physiological basis of variation in yield. *Advances in Agronomy*, *4*, 101-145.

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