Original Research Article

Effect of Different Growing Media on Hardwood Cutting of Grapes (*Vitis vinifera* L.) cv. Pusa Navrang

ABSTRACT:

Aims: Investigate the influence of different growing media on the rooting and subsequent growth of hardwood cuttings of "Pusa Navrang" grapevine**.**

Study design: Completely randomized block design

Place and Duration of Study: Research Farm, College of Horticulture, Mandsaur, during the period November 2020- March 21.

Methodology:Filling of poly bags: Before the cutting planting the 5 X 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., 360 bags of Soil, 360 bags of Soil + Sand (1:1 ratio), 360 bags of soil + sand + cocopeat (1:1:1 ratio), 360 bags of Soil + Sand + FYM (1:1:1 ratio) and 360 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.

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.

Results: The best result was found for shoot parameter like shoot length (6.75 cm, 48.15 cm), number of nodes per shoot (6.23, 14.75), internodal length (2.31 cm, 5.36 cm), number of buds per shoot (10.16, 23.72), stem diameter (14.15 mm, 24.20 mm) at 60 and 90 DAP, stem fresh weight (13.79 g), stem dry weight (5.68 g) at 90 DAP. Root Parameters like number of primary (20.11, 28.12) and secondary roots (14.74, 25.37), root length (17.98 cm, 19.69 cm), root thickness (1.81 mm and 1.95 mm), whole root volume (16.97 cm^2 and 21.72 cm^2) at 60 and 90 DAP, fresh weight of root (5.15 g), dry weight of root (2.14 g) at 90 DAP. Leaf Parameters like number of leaves per plant (9.73, 22.20) at 60 and 90 DAP, fresh weight of leaf (1.51 g), dry weight of leaf (0.63 g), leaf area (49.21 cm^2), leaf area index (3.61), specific leaf weight (23.08 $mgDw.cm^{-2}$) at 90 DAP, while minimum days taken to emergence of 1^{st} leaf (22.92 DAP) found in soil + sand + vermicompost (M_5).

Conclusion: Among five growing media the application of soil + sand + vermicompost 1:1:1 responded well in term of rooting and shooting in hard wood cutting of grapes. In order to confirm the validity of results the experiment must be repeated over years, location and different season with more accuracy.

Keywords: Growing media, hardwood cutting and grapes

INTRODUCTION

Grapes (*Vitis vinifera*) belong to the family Vitaceae are berry fruits grown on vines. This family consists of 14 living genera and thousands of domesticated and wild species. Grapes are among the most popular fruits in the commons and are valuable for human health. Vitis vinifera, also known as European grapes, are domesticated between the Black Sea and the Caspian Sea. Historians believed that these grapes were first introduced in Europe and then to all the continents by different explorers (Anonymous 2008). Grapes are widely grown to make wines, eat fresh as table grapes, and make raisins. Different studies showed that grapes consumption could reduce the risk of cancer development, heart strokes, blood pressure, and different allergies and constipation (Abebe 2017). Grapes are also a rich source of many vital nutrients like boron which promotes healthy bone growth (Demir and Serindağ 2006). Vegetative propagation through stem cutting is the most common method for planting and obtaining good plants in the horticulture industry. This method is extensively implemented in the propagation of grapes. Propagation through stem cutting has many advantages like economic, lesser space requirements, simplicity of the method, and above all, production of true-to-type plants in a short time (Alikhani *et al*., 2011). Propagation through stem cutting maintains true to type varietal characteristics (Waite *et al*., 2015). Many fruit plants like grapes, figs, pomegranate, etc., are being propagated using stem cuttings from ancient times. This method is suitable for container plantation as it provides relaxed marketing, is suitable for a more extended plantation period, and is easy to transport (Mhango *et al*., 2008)

Potting media is among one of the main factors for the success and health of stem cuttings. A potting media supports the growing plant, sustains moisture, provides water and nutrients to plants, and helps exchange gases at the root zone (Larsen and Andreasen 2004). A potting or growing medium allows cuttings to grow and extract nutrients that help in producing healthy seedlings. Along with physical properties, the media's biological activity and Physico-chemical profile can alter the growth and development of cuttings. A potting media with suitable drainage, appropriate water holding capacity, suitable amounts of soil microbes, and porosity is considered best for raising healthy plants (Ahmad *et al*., 2004). Using soil as potting media for the propagation of grapes through stem cutting is common among farmers and nursery workers. Soil generally lacksappropriate physicaland chemicalcharacteristics and has lower vital nutrients, resulting in inferior quality seedlings. Hence it is of utmost importance to choose a suitable potting media to achieve healthy seedlings as it serves as a critical source of nutrition and provides a root system to grow plants. Still, the knowledge about potting media is very limited in the farmer community and nursery growers. So, there is a need to optimize protocols for potting media by using cheap sources available at local premises and are readily available in large amounts. Hence this study was undertaken to evaluate the performance of different potting media on stem cuttings of grapes and to identify a suitable potting media for grapes cutting.

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. PusaNavrang) 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 X 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., 360 bags of Soil, 360 bags of Soil + Sand (1:1 ratio), 360 bags of Soil + Sand + cocopeat (1:1:1 ratio), 360 bags of Soil + Sand + FYM (1:1:1 ratio) and 360 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.

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.

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 60^0C. 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 milimetre.

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 thedate 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 60^0C. 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_5 (soil + sand + vermicompost) i.e., 6.75 cm, 48.15 cm followed by M_4 (soil + sand + FYM) i.e., 5.89 cm, 41.25 cm and minimum plant height of i.e., 3.79 cm, 23.05 cm was found in treatment M1 (Soil) at 60 & 90 days after planting respectively.The highest shoot length in compost may be caused by the compost's higher nutritional content, greater ability to retain water, better drainage, and higher porosity, all of which aid in the development of an ideal root system and allow plants to absorb more water and nutrients. These factors also increased the cuttings' meristematic activity, which prompted the division of cambial cells and tissue. (Bashir *et al*., 2009; Ahmad and Qasim, 2003). Similar results found by Shah *et al*. (2021) in grapes.

Number of nodes per shoot

The different treatments of growing media revealed that treatment M_5 (Soil + sand + Vermicompost) recorded maximum number of nodes which is followed by M_4 (Soil + Sand + FYM). While, the minimum number of nodes of was found in treatment M_1 (Soil) with growing media at 60, 90 days after planting. Similar result was reported by Bhatt and Tomar (2010) in lime, Singh (2013) in Citrus limon, Shahab *et al*., (2013) in alstonia, Swathi (2013) in pomegranate.

Internodal length

At 60 and 90 DAP, the longest internodal length per shoot was observed in treatment soil + sand + vermicompost (M_5) i.e., 2.31 cm, 5.36 cm followed by soil + sand + FYM (M_4) i.e., 2.16 cm, 4.83 cm while the shortest internodal length per shoot was discovered in treatment media soil (M_4) i.e., 1.68 cm, 3.61 cm respectively.Similar result was reported by Bhatt and Tomar (2010) in lime, Shahab *et al*., (2013) in alstonia, Swathi (2013) in pomegranate.

Stem diameter

The result form table revealed that at 60 and 90 days after planting maximum stem diameter among the growing media treatment recorded with soil + sand + vermicompost (M_5) i.e.,14.15 mm and 24.20 mm followed by soil + sand + FYM (M_4) i.e.,14.00 mm and 23.11 mm respectively. While the minimum stem diameter observed with treatment soil (M_1) i.e., 10.57 mm and 20.14 mm. It might be due to the use of vermicompost to improve the use of stored carbohydrates, nitrogen, and other variables, Siddiqua *et al*., (2008) in dragon fruit and Kaur Sukhjit (2017) in Flordaguard peach also recorded these results.

Number of buds per shoot

Treatment soil + sand + vermicompost (M_5) i.e., 10.16, 23.72 had the most buds per shoot across the growth media, followed by soil + sand + FYM (M_4) i.e., 9.17, 21.46 at 60 and 90 days after planting respectively. Similarly, soil alone observed lowest number of buds per shoot in treatment (M_1) i.e., 6.01 and 15.26 at 60 and 90 days after planting respectively.It related to the presence of a greater number of tiny pores in the vermicompost and FYM media, as well as the availability of air and nutrients. Shadparvar*et al*., (2011) in Hibiscus, Manila *et al*., (2017) in pomegranate and Padekar *et al*., (2018) in hibiscus recorded same results.

Stem Fresh weight

The data (Table-1) revealed that, the stem fresh weight recorded significantly highestwith treatment soil + sand + vermicompost (M_5) recorded maximum fresh weight of stem i.e., 13.79 g followed by treatment soil + sand + FYM (M_4) i.e.,13.05 g, while the minimum fresh weight found with treatment soil (M_1) i.e., 9.76 g. 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.

Stem dry weight

It was apparent from the results (table 4.) the growing media, maximum dry weight of plant i.e., 5.68 g was noted in the treatment soil + sand + vermicompost (M_5) followed by treatment soil + sand + FYM (M_4) i.e., 5.25 g and while, minimum dry weight of stem recorded in treatment soil (M_1) i.e., 3.68 g at 90 days after planting. This could explain by the fact that auxins This might be because of adding vermicompost to other medium increases water holding capacity, which 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 (2018) *et al*., in Fig and Singh (2017) in pomegranate.

B. Root Parameters

Number of primary and secondary roots

The data (Table-2) revealed that, highest number of primary roots per cutting was found in case of treatment soil + sand + vermicompost (M_5) i.e., 20.11 and 28.12 followed by soil + sand + FYM (M_4) i.e., 19.58 and 24.09. Whereas, the lowest number of primary roots per cutting observed in treatment soil (M_1) i.e., 16.45 and 19.60 had recorded at 60 and 90 days after planting, respectively.

The data (Table-1) revealed that, maximum number of secondary roots per cutting were found in treatment soil + sand + vermicompost (M_5) i.e., 14.74 and 25.37 followed by soil + sand + FYM (M_4) i.e., 13.03 and 24.00. While the minimum number of secondary roots per cutting were reported with growing media treatment soil (M_1) i.e., 9.74 and 19.57 at 60 and 90 days after

planting, correspondingly. The present study confirmed that Compost and sand had increased the number of roots in grape cuttings due to these media's improved physical, chemical, and biological properties (Arancon*et al*., 2005).

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
Soil	3.79	23.05	4.93	9.52	1.68	3.61	10.57	20.14	6.01	15.26	9.76	3.68
Sand	4.37	28.77	5.35	10.43	1.83	3.95	11.69	20.84	6.95	17.43	10.69	4.14
Cocopeat	5.31	33.93	5.69	11.38	2.03	4.41	12.92	21.98	7.74	19.14	12.39	4.92
Soil + Sand + FYM	5.89	41.25	5.98	12.79	2.16	4.83	14.00	23.11	9.17	21.46	13.05	5.25
Soil + Sand + Vermicompost	6.75	48.15	6.23	14.75	2.31	5.36	14.15	24.20	10.16	23.72	13.79	5.68
S.Em±	**0.11**	**0.60**	**0.08**	**0.24**	**0.04**	**0.06**	**0.34**	**0.46**	**0.22**	**0.48**	**0.25**	**0.13**
CD (%)	**0.31**	**1.73**	**0.24**	**0.69**	**0.12**	**0.17**	**0.99**	**1.33**	**0.63**	**1.37**	**0.71**	**0.36**

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
Soil	16.45	19.60	9.74	19.57	11.66	12.31	1.68	1.79	12.13	15.36	3.44	1.30
Sand	17.47	20.54	10.68	20.85	12.97	13.28	1.71	1.82	12.69	17.06	3.87	1.50
Cocopeat	18.73	22.29	12.38	22.56	14.71	15.50	1.74	1.85	14.41	18..75	4.31	1.71
Soil + Sand + FYM	19.58	24.09	13.03	24.00	16.93	17.18	1.79	1.91	15.43	20.22	4.76	1.94
Soil + Sand + Vermicompost	20.11	28.12	14.74	25.37	17.98	19.69	1.81	1.95	16.97	21.72	5.15	2.14
S.Em±	**0.07**	**0.59**	**0.31**	**0.47**	**0.34**	**0.40**	**0.01**	**0.01**	**0.33**	**0.44**	**0.12**	**0.09**

CD (%)	**0.21**	**1.70**	**0.90**	**1.36**	**0.97**	**1.14**	**0.04**	**0.04**	**0.93**	**1.27**	**0.34**	**0.25**

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**	**Specific Leaf Weight ($mgDW.cm^2$)**
		At 60 DAP	**At 90 DAP**	**At 90 DAP**	**At 90 DAP**	**At 90 DAP**	**At 90 DAP**	**At 90 DAP**
Soil	26.00	6.03	13.39	1.18	0.44	28.29	2.09	12.61
Sand	25.23	6.45	14.51	1.25	0.49	40.24	3.10	14.72
Cocopeat	24.25	7.42	17.76	1.33	0.52	42.28	3.30	16.97
Soil + Sand + FYM	23.50	8.13	20.30	1.40	0.57	46.43	3.44	18.24
Soil + Sand + Vermicompost	22.92	9.73	22.20	1.51	0.63	49.21	3.61	23.08
S.Em±	0.37	0.18	0.46	0.02	0.02	0.90	0.06	0.77
CD (%)	1.05	0.51	1.33	0.07	0.05	2.59	0.17	2.20

The highest number of roots in Compost is related to the higher electrical conductivity values, higher water and nutrient retention abilities, supply of adequate aeration, and presence of beneficial growth-regulating substances like micro-organisms (Moradi *et al*., 2014). It was noted that the performance of soil in terms of root development was unsatisfactory. This might be because of decomposed organic material which improves soil fertility by improving aeration, water holding capacity and infiltration, resulting in maximum root development. These results are agreed with the findings of Akshay *et al*., (2014) in black pepper, Irshad *et al*., (2014) in kiwi fruit, Mishra *et al*., (2014) in air layering of kagzi lime, Kumar *et al*., (2015), Manila *et al*., (2017) in pomegranate, Rajkumar *et al*., (2017) in pomegranate and Shah *et al*. (2021) in grapes.

Root length

The data (Table-2) revealed that, root length were significantly highest with M_5 (soil + sand + vermicompost) i.e., 20.56 cm and 21.86 cm followed by IBA @ 4000 ppm (G2) i.e., 19.22 cm and 20.60 cm. While, minimum root length of longest root observed in treatment IBA @ 0 ppm (G0) i.e., 7.79 cm and 8.56 cm had recorded at 60 and 90 days after planting, respectively.The current results confirm the reports of Venkatesan *et al*. (2010) and Choeichit*et al*. (2013) in stem cuttings of Gymnemasylvestre and cassava, respectively. The length of roots depends upon their ability to penetrate in growing media, which in turn depends upon the porosity of the media; the more significant the porosity, the greater the penetration, and the greater the length of the root. Thus, due to the compact nature of Soil and less porosity, it hindered the growth and penetration of roots which were also reported by Mehmood *et al*. (2013) in Floral Shower (*Antirrhinum majus* L.)These findings are in agreement with the findings of Barde *et al*., (2010) in pomegranate, Kumawat *et al*., (2010) in pomegranate, Alikhani (2011), Akshay *et al*., (2014)in black pepper, Kumar *et al*., (2015), Rajkumar *et al*., (2017) in pomegranate, Netam *et al*., (2020) in pomegranate and Shah *et al*. (2021) in grapes.

Root thickness

Highest root thickness was found in case of treatment soil + sand + vermicompost (M_5) i.e., 1.81 mm and 1.95 mm. Though, the lowest root thickness was observed in treatment soil (M_1) i.e., 1.68 mm and 1.79 mm at 60 and 90 days after planting, respectively.This might be because decomposed organic material improves soil fertility by improving soil aeration, water holding capacity and infiltration, as well as reducing surface crusting, 96 resulting in maximum root diameter. These findings are in agreed with the findings of Manila *et al*., (2017) in pomegranate, Ghani *et al*., (2019) in pomegranate, Netam *et al*., (2020) in pomegranate.

Whole root volume

Highest whole root volume per cutting was assessed in treatment soil + sand + vermicompost (M_5) i.e., 16.97 cm^2 and 21.72cm^2. Lowest whole root volume per cutting observed in sole soil (M_1) i.e., 12.13 cm^2 and 15.36 cm^2 at 60 and 90 days after planting, respectively.It may be due to higher root length which is accumulated more stored carbohydrates and more number of roots increased their volume (Hartman *et al*., 1997). Similar results also reported by 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_5 (soil + sand + vermicompost) i.e., 5.15 g in hard wood cuttings at 90 DAP. Minimum fresh weight of root was recorded in treatment M_1 (soil) i.e., 3.44 g at 90 DAP. This might be because more root length and root whole volume, which resulting in higher fresh root weight. These findings are in agreement with the findings of and Akshay *et al*., (2014)in black pepper, Manila *et al*., (2017) in pomegranate, Rajkumar *et al*., (2017) in pomegranate, Farooq *et al*., (2018) in grapes, Ghani *et al*., (2019) in pomegranate, Netam *et al*., (2020) in pomegranate.

Dry weight of root

The data (Table-2) revealed that, the stem dry weight recorded significantly highest with M_5 (soil + sand + vermicompost) i.e., 2.14 g in hard wood cuttings at 90 DAP. Minimum dry weight of root was recorded in treatment M_1 (soil) i.e., 1.30 g at 90 DAP.This might be due to increased synthesis and accumulation of growth promoting substances, as well as the availability of additional nutrients, all of which raise the fresh weight of root and ultimately increase in dry weight of roots when given this treatment.Similar findings were also reported by Akshay *et al*., (2014)in black pepper, Manila *et al*., (2017) in pomegranate, Rajkumar *et al*., (2017) in pomegranate, Farooq *et al*., (2018) in grapes, Ghani *et al*., (2019) in pomegranate, Netam *et al*., (2020) in pomegranate.

C. Leaf Parameters

Days taken to emergence of 1st leaf

Treatment M_5 (soil + sand + vermicompost) found minimum number of days to emergence of 1st leaf after planting i.e., 22.67. While the maximum number of days taken by treatment M_1 (26.00) after 90 days after planting.This might related to the increased concentration of metabolites in vermicompost medium, which promotes early development. Similar findings were also reported by Ahmad and Qasim (2003), Akshay *et al*.,

(2014)in black pepper, Kumar *et al*., (2015), Farooq *et al*., (2018) in grapes, Padekar *et al*., (2018) in Kartoli, Ghani *et al*., (2019) in pomegranate and Shah *et al*. (2021) in grapes.

Number of leaves per plant

The data (Table-3) revealed that, number leaves per plant were significantly highest with M_5 (soil + sand + vermicompost) i.e., 9.73 and 22.20 in hard wood cuttings at 60 and 90 DAP. Minimum number of primary roots was recorded in treatment M_1(soil) i.e., 6.03 and 13.39 at 60 and 90 DAP respectively. The number of photosynthetically active leaves depends upon the better root and shoot growth, which relies on biological and physical characteristics of the potting media. The bud opening depends upon the biochemical process occurring inside the stem and bud cells; appropriate levels of minerals and nutrients inside the plant allow to form new and to open dormant buds. As by previous results, Compost has increased the number of roots and shoots, which might be a reason to increase the number of leaves in grape cutting. The findings were supported by Soni, *et al*., (2015) and Soni, *et al*., (2016) in guava, Manila *et al*., (2017) in pomegranate, Farooq *et al*., (2018) in grapes, Ghani*et al*., (2019) in pomegranate and Tanwar *et al*., (2020) in pomegranate and Shah *et al*. (2021) in grapes.

Fresh weight of leaf

The data (Table-3) revealed that, the fresh weight of leaf was recorded significantly highest with M_5 (soil + sand + vermicompost) i.e., 1.51 g in hard wood cuttings at 90 DAP. Minimum fresh weight of leaf was recorded in treatment M_1 (soil) i.e., 1.18 g at 90 DAP. This might be because decomposed organic matter improves soil fertility by improving aeration, water holding capacity and infiltration. The lowest performance of rooted cuttings is in soil that was due to a nutritionally deficient medium devoid of organic material, resulting in the least fresh weight of leaves. These results are consistent with the findings of Akshay *et al*., (2014)in black pepper, Farooq *et al*., (2018) in grapes.

Dry weight of leaf

The data (Table-3) revealed that, the dry weight of leaf was recorded significantly highest with M_5 (soil + sand + vermicompost) i.e., 0.63 g in hard wood cuttings at 90 DAP. Minimum dry weight of leaf was recorded in treatment M_1 (soil) i.e.,0.44 g at 90 DAP.This might be because the winter season offers the greatest environmental conditions for growth that increases fresh & dry weight of leaves. These findings are in line with the findings of AbouzarAbouzari*et al*., (2012) and Akshay *et al*., (2014)in black pepper.

Leaf Area

Maximum leaf area was found with soil + sand + vermicompost (M_5) i.e., 49.21 cm^2. While, the minimum leaf area observed with soil (M_1) i.e., 28.29 cm^2 at 90 days after planting. This might be due to enhanced absorption of minerals from the vermicompost and FYM, particularly iron and magnesium, resulting in increased photosynthetic activity, which increases leaf area. Same results found by Burman *et al*., (2016) in grapes and Ghani *et al*., (2019) in pomegranate.

Leaf Area Index (LAI)

The data (Table-3) revealed that, the leaf area index was recorded significantly highest with M_5 (soil + sand + vermicompost) i.e., 3.61 in hard wood cuttings at 90 DAP. Minimum leaf area index was recorded in treatment M_1 (soil) i.e.,2.92 at 90 DAP. This might be due to enhanced absorption of minerals from the soil, particularly iron and magnesium, leading to increased photosynthetic activity, which increases leaf area index, Muhabat Shah *et al*., (2006) shown same results.

Specific leaf weight (mgDW.cm^{-2})

Maximum specific leaf weight was observed in soil + sand + vermicompost (M_5) i.e., 23.08 mgDw.cm^{-2}. While the minimum specific leaf weight recorded in soil (M_1G_0) i.e., 12.61 mgDw.cm^{-2} at 90 DAP.

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 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.

Recommendations: Among different media, it is recommended that Nurserymen should use Compost for successful commercial production of healthy grape plants.

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