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Peer-reviewed version available at *Sustainability* **2017**, *9*, 1275; doi:10.3390/su9071275

Article

Determination of Some American Grapevine Rootstocks' Suitability for Vertical Gardens as a New Edible Landscape Component

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ABSTRACT: In this study, grapevine, which epitomizes the opinion that vertical gardens can have a positive influence on human psychology with their beautiful view as in the example of hanging gardens of Babylon about 2500 years ago, was used as the research material.

The study in question was conducted in Bingol University, Faculty of Agriculture, the Department of Garden Plants research and application area in 2016.

The offshoot growth was measured in fertilizer experiment formed as control, 1st application (200 gr/100 lt water, leaf) and 2nd application (100 gr/100 lt water+40% leaf+root) and its footprint in the vertical area was determined.

While the average offshoot growth of 1103 P American grapevine rootstock in the 1st and 2nd applications was measured as 61,5 cm and 39,5 cm respectively, it was 43,0 cm and 51,0 for C American grapevine rootstock. The average growth of 1103 P and 1616 C American grapevine in the control group was determined as 30,6 cm and 32,1 cm.

The average growth of both American grapevine rootstocks used in the experiment was determined to be higher for the 1st and 2nd applications than the controls.

Key Words: American grapevine rootstocks; vertical garden; offshoot growth; footprint

1. Introduction

Grapevine, which is a significant branch of agricultural sector and a valuable plant species having accompanied humankind's journey of knowing oneself, has reached its present status by being improved in accordance with human needs with its historical importance and sacred values ascribed by many religions.

Turkey has been the cradle and center of especially viticulture throughout history because of its climatic and soil characteristics (1). Accoring to TÜİK (2014) data, 4.011.409 tons of grapes were cultivated in 4.687.922 decare field in Turkey; 2.132.602 tons of this amount were table grapes, 1.423.578 tons were for dessication, 455.229 tons were wine rack. 4.185.126 tons and 4.296.351 tons of grapes were cultivated in 2012 and 2011, respectively (2)

Grapevine is economical in terms of grape output and it is a significant plant of Turkey with respect to its diversity and genetic material (3), (4).

Taking health into consideration, grape boosts immune system, increases the function of the kidney and the liver, becomes effective in the treatment of liver diseases and anemia. Moreover, it enables blood to be cleansed, body fat to be dissolved, harmful substances accumulating in body to

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be removed, cardiovascular system to function regularly by inhibiting the accumulation of fatty compounds in capillary vessels.

Because it has been determined in recent studies that grape participates in the protection of the body against cancer, it makes the body resistant against viruses, it accelerates digestion without harming the stomach with its skin or seeds, and it regulates the intestinal system thanks to the resveratrol substance it contains, the significance of grapevine and grapes has increased still further (5)

Moreover, the opportunity to find nature in cities where green-fields decrease more and more decreases because of structuring, because open spaces are not scattered equally in the city. It is possible to find large and interrelated forests and light green fields in the city edges. However, green fields are almost nonexistent in densely populated areas. Existing green fields are in small fractions scattered throughout all the city, which are the remains of ruined natural vegetation having covered large areas in the past (6). At first, roof surfaces and yards were used to vegetate the buildings. However, the fact that front facades cover more space resulted in the vegetation of these areas, providing benefit for both the building and the environment. As a result of all these developments, the concepts of living walls, green facades and wall vegetation were developed with new researches. In a study conducted in Toronto University, a model vertical garden was built and it was determined that the amount of the energy spent for air circulation, energy consumption and cooling decreased. The same study became helpful in reducing the obstacles to the proliferation of vertical gardens such as lack of knowledge, lack of incentive for application, the obstacles based on cost, technical problems related to uncertainty and risks (7).

Accordingly, it is obvious that, in the past, especially grapevines were used in vertical gardens. Vertical garden is an idea that is as old as the cities and first appeared in Babylon 2500 years ago. King Nebuchadnezzar II had Hanging Gardens of Babylon, which are regarded as the ancestor of green walls by many people today, built. As a matter of fact, Hanging Gardens of Babylon included green roofs in addition to green walls (8).

The use of grapevine -which took a place in our lives at all points thanks to its various uses, its significance for nutrition and human health, its use in architecture and decoration in the past- in environmental planning and landscaping led to the opinion that it can have a good effect on human psychology with its pleasant outlook.

This study was conducted, in accordance with this opinion, in order to investigate the usability of grapevine as vertical garden and edible landscaping element in continental climate with minimum cost while vertical green surfaces are accepted as one of the best ways to create sustainability in especially urban areas.

2. Material and Method

2.1. Material

This study was conducted in Bingol University, Faculty of Agriculture Research and Application Area in 2016. Taking the climatic conditions of Bingol city into consideration, 1103 P and 1616 C American grapevine rootstocks, which are recommended for many regions in our country with continental climate, were used as vegetative material in the experiment.

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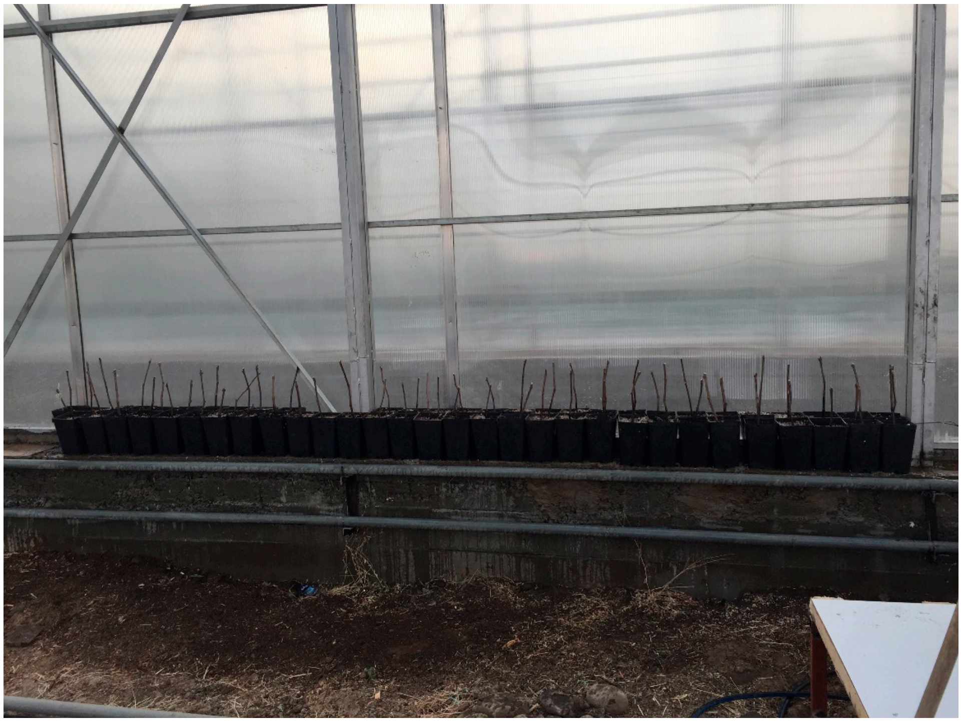

Picture 1. Cuttings taken to rooting environment in vases

Picture 2. Cuttings belonging to 1103P rootstock

2.1.1. Some characteristics of 1103 P American grapevine rootstock

Offshoot point is hairy like spider web and pink. Young leaves are hairless and bronze. Ripe leaves are kidney-shaped and petiolar sinus is U-shaped (Figure 3.1). Their internodes are purple, half-hairy, and have female and sterile flower structure. This rootstock which grows strongly can

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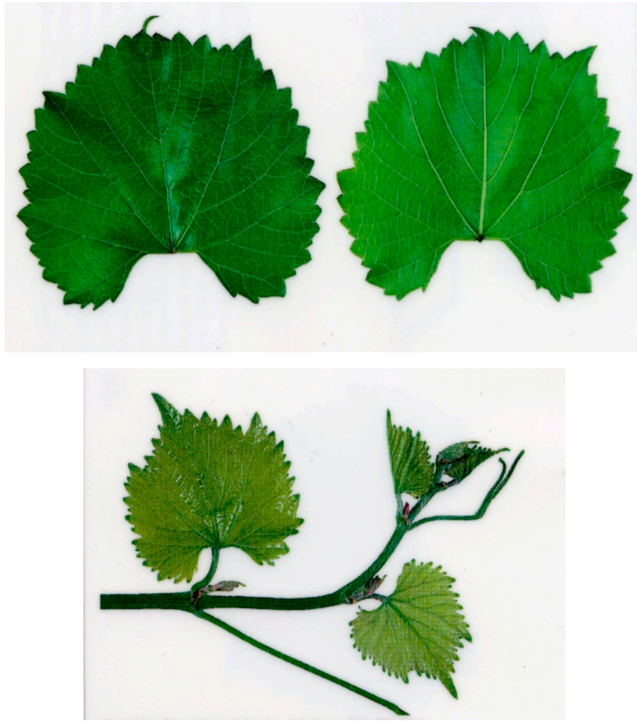
resist active lime in 17-18% ratio. It is resistant against 0,6 g/kg salt. The rate of its taking inoculation and root is very high (9), (3), (10), (11).



Pciture 3. 1103 P American grapevine rootstock (11)

2.1.2. Some characteristics of 1616 C American grapevine rootstock

Offshoot point is hairy like spider web, young leaves are pale green and hairy like spider web. Ripe leaves have 5 corners and leaf sinus is open, lyre-shaped. It has typical female flower characteristics and cluster small black grains. Yearly bars are pinstriped and internodes are long.

It can grow better in humid soils and its inoculation can accelerate its ripening.

1616 C American grapevine rootstock is pretty durable against phylloxera and its resistance against lime is about 11% (3)

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Picture 4. 1616 C P American grapevine rootstock (11)

2.2. Method

2.2.1. Obtaining the cuttings, their protection and planting

1103 P and 1616 C American grapevine rootstock cuttings used in the experiment were obtained from Manisa Vitivulture Research Station Management. These cuttings were taken from the well-lignified middle parts of one-year-old branches following the defoliation, as Roux reported (1988) (12), their lengths were adjusted to 30-40 cm according to TS-4027, the ones with 8-12 mm diameter were fastened in bunches of 50 (13) and they were preserved in polyethylene plastic bags in cold storages having +4 ^{o}C temperature and 95-98% relative humidity (14)

Pearlite+Peat+garden soil mixture in 1:1:2 proportion was used as the rooting environment. Analysis results belonging to the environment used in rooting was given in Chart 1. Rooting environment having been prepared in the stated proportions was scattered among the vases of 14x14x20 cm sizes, about 1625 gr for each one. The cuttings belonging to the rootstocks which were taken to these rooting vases were planted by blunting the buds and keeping two buds out (on 06.04.2016).

Table 1. Some analysis results belonging to the environment used in rooting

Measure Parameter	Unit	Value
Nutrient Media Ph	-	7,95
CaCO3 proportion in nutrient media	%	4,95
Organic Substance Amount in nutrient media	%	78,24
Electricity Conductivity in nutrient media	dsS/cm	0,317

2.2.2. Setting up the experiment

The study was supported with the applications on 6 different groups. The cuttings planted in the vases started to shoot stocks on 11.04.2016 and this continued until 21.04.2016.

As from 21.04.2016 when grapevine buds completely shot stocks, grapevines were taken out of the greenhouse environment to a field with a northern exposure in order for them to adapt to outside conditions. After being kept here for almost a week, it was transfered to the open space where the experiment would be set up.

The cuttings which were irrigated at regular intervals were also subjected to the necessary cultivation processes. To provide homogeneity for the cuttings having shot stocks, the cutting other than the ones which reached a specific height (5-10 cm) were cut by pruning and taken away from the cuttings which shot stocks.

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2.2.3. The application of fertilization in the cuttings used in the experiment

15 vases were used for each application -1 cutting of shooting stock in each vase- in the experiment which was set up according to randomized blocks experimental design.

The experiment was set up as Control, 1st Application and 2nd Application and no application was conducted on the control group. Fertilizer solution in 200gr/100 lt water concentration was applied through the leaf. Fertilizer solution in 100gr/100 lt water concentration was applied through the leaf, fertilizer solution in 40% gr-water concentration was applied on the root (150 cc/cutting) five times every 10 days starting from 21.07.2016.

The Fertilizer used in the applications was of 20+20+20+ME and the plant nutrition elements it contained is given in Chart 2.

Table 2. Nutrition element contents of the fertilizer used in the applications

Nutrition Element in the Fertilizer	W/W
Nitrate Nitrogen	6%
Ammonium Nitrogen	5,10%
Urea Nitrogen	8,90%
Total Nitrogen (N)	20%
Water Soluble Phosphorpenta (P_2O_5)	20%
Water Soluble potassium oxide (K_2O)	20%
Water Soluble Boron(B) (All are EDTA and Chelate)	0,01%
Water Soluble Copper (Cu) (All are EDTA and Chelate)	0,006%
Water Soluble Iron (Fe) (All are EDTA and Chelate)	0,02%
Water Soluble Manganese (Mn) (All are EDTA and Chelate)	0,02%
Water Soluble (Zn) (All are EDTA and Chelate)	0,02%

3. Research findings

Grapevine rootstocks taken out of the greenhouse environment were kept waiting until they grew ripe and the applications started on 21.07.2016. These applications were conducted in 5 recurrences in 10 days-intervals.

Height averages of the offshoots in 200 foliar fertilization application (1st application) in 1616 C American grapevine rootstock group were measure as 56,2 cm. It was observed that after foliar fertilization was applied on 1616 C American grapevine rootstocks, the offshoots grew between 43 cm and 25 cm and the average offshoot growth was 34,4 cm. 40% of the offshoots belonging to this rootstock grew over 35 cm. (Picture 5)

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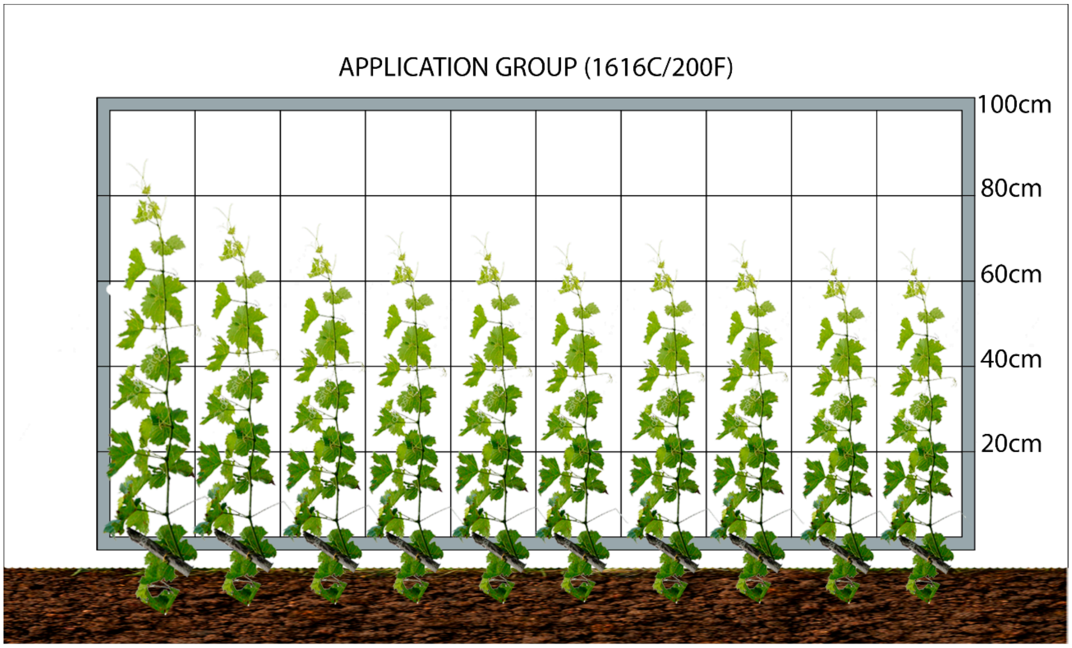
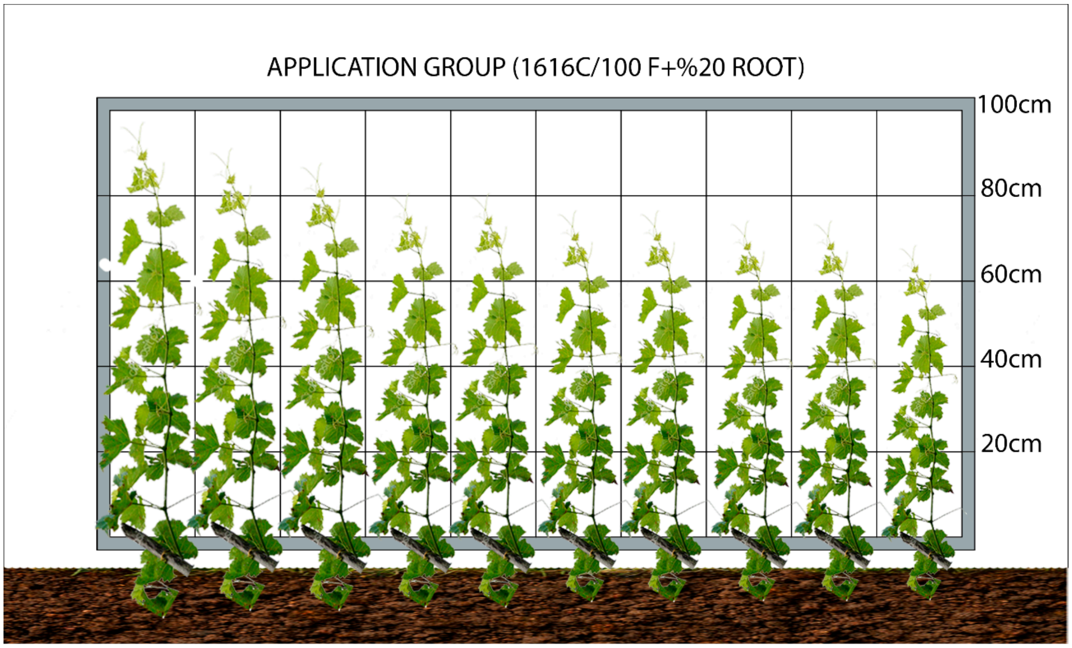


Picture 5. Offshoot development belonging to 1st application in 1616 C American grapevine rootstocks (Graphics were made by adding the growth amounts to the average height before the application, based on 10 rootstocks which grew at the most.)

When 20% root and 100 foliar fertilizer was applied to the same rootstocks (2nd Application), it was observed that the average height of offshoots is 60,3 cm. After the fertilization was applied to 1616 C American grapevine rootstock, it was observed that offshoots grew between 51 cm and 32 cm and average growth was 37,9 cm 66,6% of 1616 C American grapevine rootstocks showed a growth of over 35 cm.



Picture 6. Offshoot development belonging to 2nd application in 1616 C American grapevine rootstocks (Graphics were made by adding the growth amounts to the average height before the application, based on 10 rootstocks which grew at the most.)

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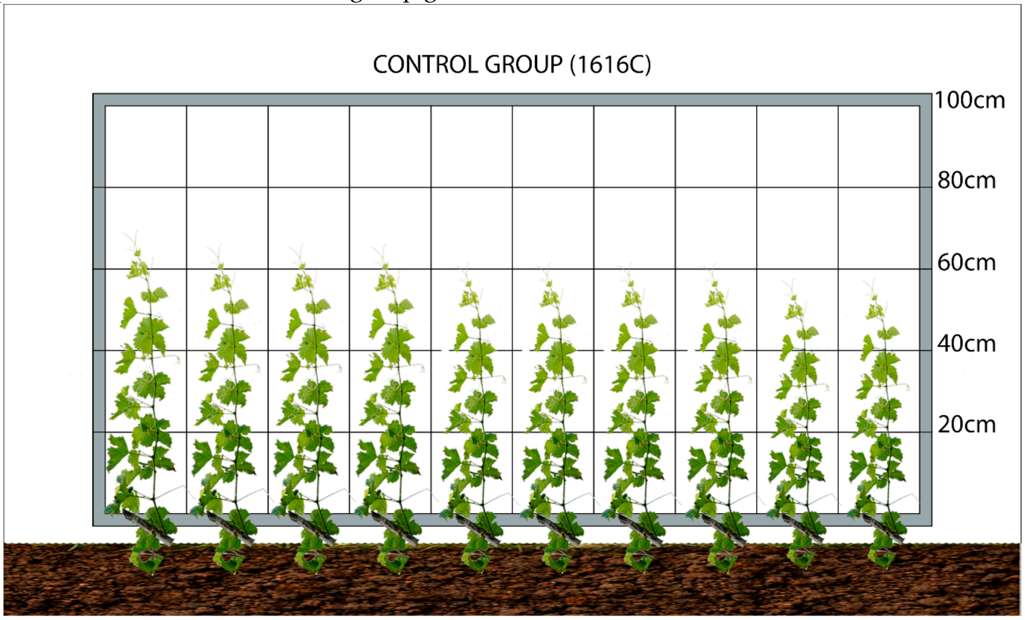
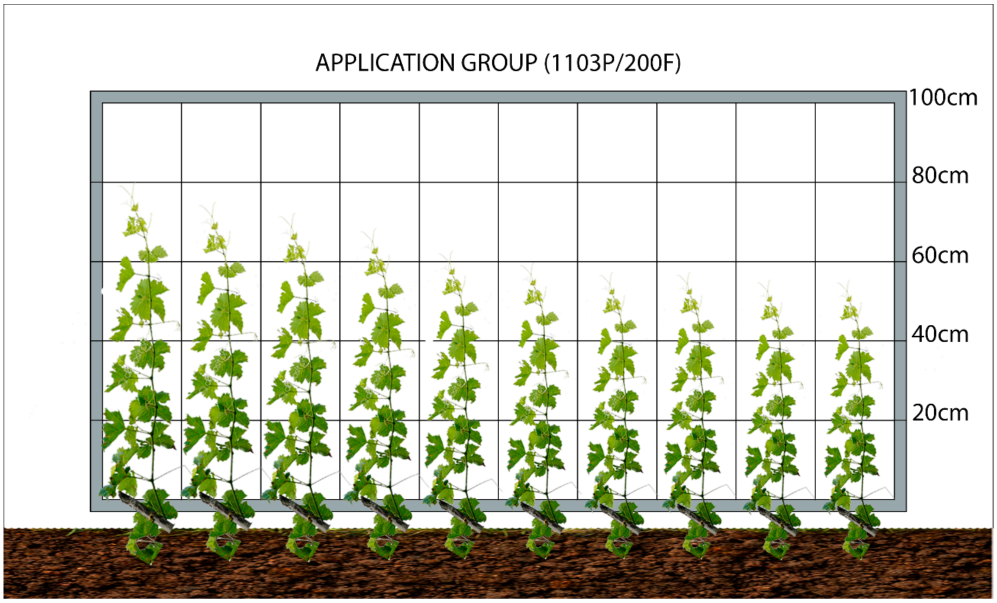
When the control groups in the same rootstocks were observed, it was determined that the average growth in the offshoots is 59,9 cm. Control group offshoots grew between 40 cm and 26 cm and the average growth was 32,1 cm. The 13,3% of the offshoots belonging to 1616 C American grapevine rootstocks in the control group growth over 35 cm.



Picture 7. Offshoot development belonging to control group 1616 C American grapevine rootstocks (Graphics were made by adding the growth amounts to the average height before the application, based on 10 rootstocks which grew at the most.)

Height averages of the offshots having grown in 200 foliar fertilization application (1st application) in 1103 P American grapevine rootstock group were 80,5 cm. It was observed that after foliar fertilization was applied on 1103 P American grapevine rootstocks, the offshoots grew between 84,0 cm and 46,0 cm and the average offshoot growth was 61,4 cm. The entire offshoot belonging to this rootstock grew over 35 cm.



Picture 8. Offshoot development belonging to 2nd application in 1103 P American grapevine rootstocks (Graphics were made by adding the growth amounts to the average height before the application, based on 10 rootstocks which grew at the most.)

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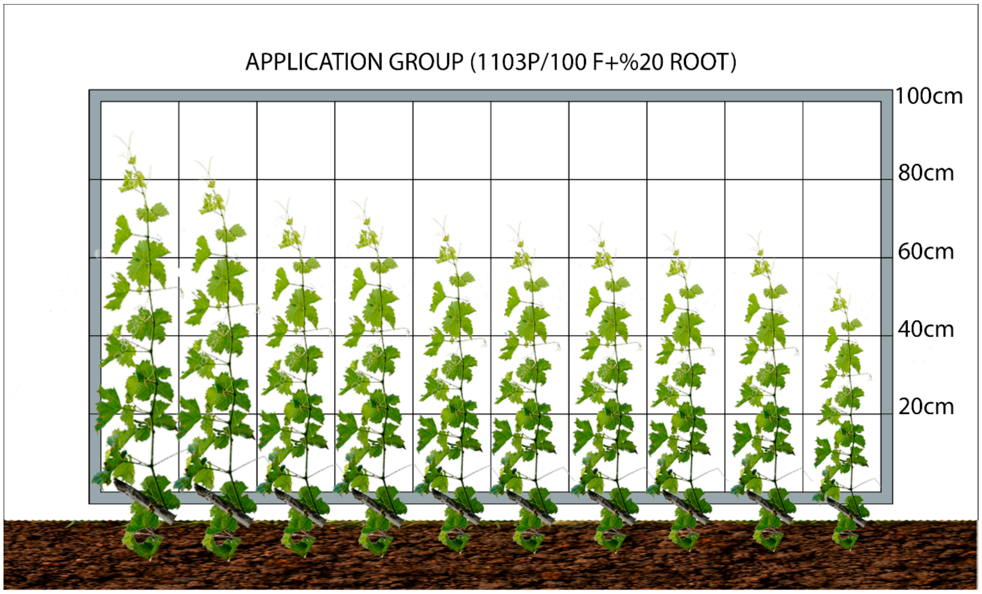
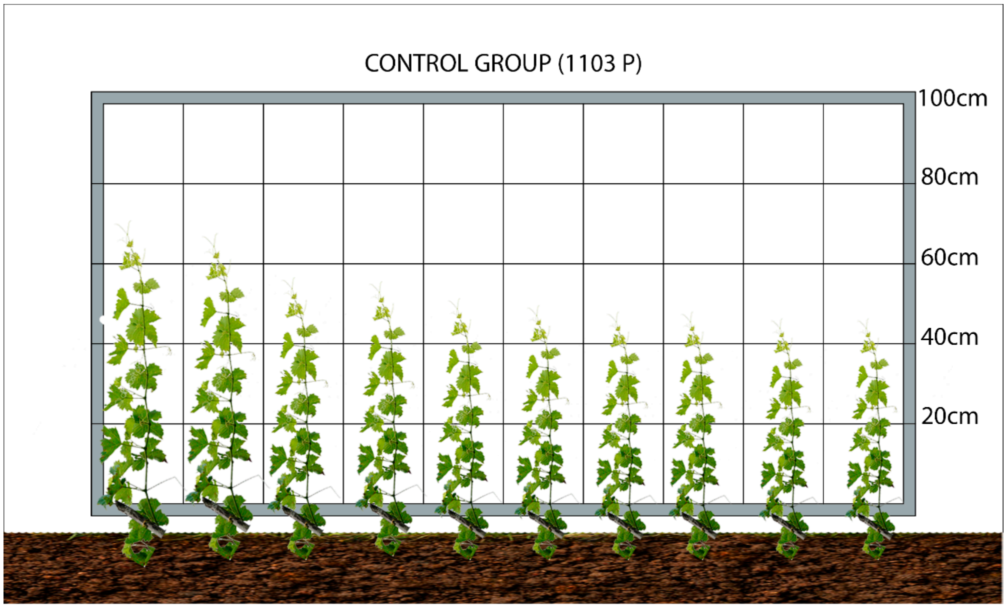
When 20% root and 100 gr/100 lt water foliar fertilizer was applied to the same rootstocks (2nd Application), it was observed that the average height of offshoots is 56,3 cm. After the fertilization was applied to 1103 P American grapevine rootstock, it was observed that offshoots grew between 57cm and 27 cm and average growth was 39,5 cm. 80,0% of 1103 P C American grapevine rootstocks showed a growth of over 35 cm.



Picture 9. Offshoot development belonging to 2nd application in 1103 P American grapevine rootstocks (Graphics were made by adding the growth amounts to the average height before the application, based on 10 rootstocks which grew at the most.)

When the control groups in 1103 P American grapevine rootstocks were taken into consideration, it was determined that the average growth in offshoots was 50,5 cm. The offshoots in the control group grew between 45,0 cm and 23,0 cm, 30,6 cm on average. Only 6,6% of the offshoots of 1103 P American grapevine rootstocks in the control group grew over 35 cm.



Picture 10. Offshoot development belonging to control group 1103 P American grapevine rootstocks (Graphics were made by adding the growth amounts to the average height before the application, based on 10 rootstocks which grew at the most.)

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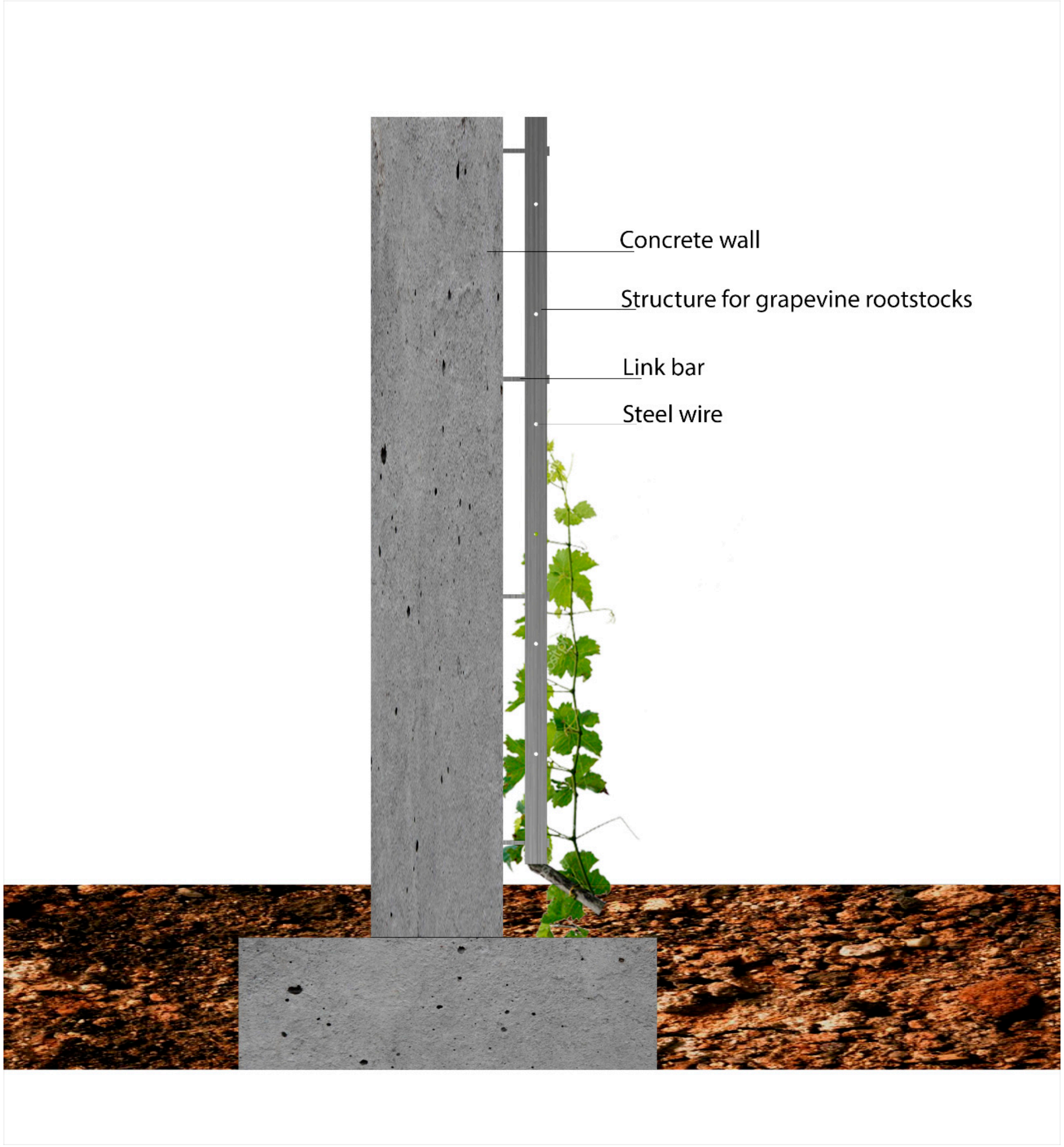
4. Discussion and result

It was determined in the studies that the rootstocks on which 20% root and 100 leaf fertilizers were applied showed the best development among the experiment groups. Although 1103P rootstock showed the best development, it was observed from the footprints (average 61,4 cm) that both rootstocks covered the same space. It was also observed that 1616C rootstock closed the footprint gap at the end of the application, since it showed a better development in the period until fertilization. For Bingol where experiment was conducted, it is more convenient to use 1616C rootstock when the use of fertilizer is not desired, while it is more convenient to use 1103P rootstock if fertilizer is to be used, since more space will be covered in this way.



Picture 11. Grapevine rootstock supportive system section for building a green wall

It was calculated as result of the studies that the cost was 40-75 €/m² for the walls supported by wires and knitted wire systems, the cost was about 800 €/m² for the walls on the surfaces of which boxes were used for the need of habitat, the cost is 1200 €/m² for living wall systems (15).

The cost, along with one-year fertilizer maintenance, was calculated to between 30-40 €/m² for this system built with American Grapevine Rootstocks (See Table 3)

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Table 3. m[2] cost of grapevine rootstock supportive system for building a green wall

Item Number	Pose Number	The Kind of Manufacturing	Unit	Amount	Unit Price (€)	Price (€)
1	Y.23.176	Making various ironworks from sheet and profile iron and putting them in their position	kg	5,240	2,075	10,873
2	04.435/10 A	Diameter 5x150 mm Mortared anchor (bar) (stainless cutting 304)	Number	6,000	0,12	7,82
3	1140	Flax essence galvanised cutting rope (Ø3/4")	M	8,000	2,33	18,64
4	ÖBF-1	American Grape-vine Rootstock Provision	Numeber	5,0000	0,07	0,35
5	ÖBF-2	Fertilisation (One-year cost)	Kg	0,198	7,81	1,54
					Total :	39,223 €

In spite of the fact that vertical green surfaces are determined extremely important by many scientists, urban planners, landscape architects and several other professionals; it is clear these vertical habitats are not as common as they should have been in many parts of the world. As many people living especially in developing countries often want to see some basic benefits in short terms as soon as they make an investment, these green magical surfaces might sometimes be far from their pragmatic perspectives, which can be described as a tough challenge. However, there is no doubt that using edible plants such as grapevine for vertical gardens can create a great support for them especially among these countries, which naturally makes a great contribution to sustainable and more livable cities.

Conflicts of Interest: The authors declare no conflict of interest.

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