Article

Green garbage substrates for growing geranium (*Pelargonium* spp.) in container

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Abstract

In Mexico, the forest land is the main substrate used in the production of containerized ornamental plants, but its unlimited extraction causes a negative ecological impact. Among the alternatives for the replacement of the land of forest, are the garbage of gardening also called "green garbage". There is a possibility that the inclusion of green waste as a substrate in the cultivation of containerized ornamental plants, have significant effects on the characteristics of growth and development of the same, so that the objective of this work was to characterize and determine the optimal dose for use as a substrate component for the production of containerized geranium. Physical chemistry laboratory analyzes were carried out and an agronomic evaluation experiment was carried out. Different proportions (100, 75, 50 and 25%) of green waste and scrubland were mixed, complemented with a general substrate (coconut fiber and sawdust, 50/50, v/v). A completely randomized design of eight treatments with eight repetitions was used. It was concluded based on the results that green waste has physicochemical characteristics similar to the land of the forest. In the growth and development of geranium in container, the results were statistically equal between the treatments of 100% of green waste and forest land in 16 variables studied. The green waste is a material that used as a substrate has the physicochemical characteristics necessary to successfully replace the land of forest in the cultivation of containerized geranium.

Keywords: *Pelargonium* spp., alternative substrates, container culture.

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Introduction

Ornamental horticulture is the branch of general horticulture that commercially exploits physically aesthetic plants, either the entire plant or some of its parts that present an attractive visual or aromatic type, and that in their natural state have the function of decorating any site for enjoyment of people (Morán-Medina, 2004). In much of the world the production of flowers takes place in greenhouses, which are closed structures and covered by transparent materials, within which it is possible to obtain artificial microclimate conditions and with that, to grow plants out of season under optimal conditions. Flower production is a very lucrative business that generates profits of 55 billion dollars per year around the world (Cárdenas, 2016).

In Mexico, ornamental horticulture is a relevant activity that generates approximately two billion pesos per year, which is due to its ideal geographic, climatological and phylogenetic conditions that allow it to be one of the most important producers and marketers of ornamental plants in the world. (Ayala-Garay and Carrera-Chávez, 2012). In Mexico, during 2013, the cultivation of the flower and potted plants was carried out in 23 000 ha, producing mainly flowers, plants and trees in containers (pot or bag) or in plantation to the ground, in greenhouse modalities, shade mesh or open sky (SIAP-SAGARPA, 2011).

The state of Morelos is considered one of the main producers of ornamental plant in container in the national scope, since by its climatic conditions it produces a great diversity of species, such as cut flowers, pot plants and cover foliage, allowing with it contribute considerably in the economy of the entity. In 2013, Morelos was the main national producer of ornamental plants and flower pots occupying 3 100 ha, of which 58% was cultivated in the open, 20% in the greenhouse and 22% in the shade, where more than 800 species and 20 000 jobs were generated (Martínez-Martínez, 2014).

Among the main species grown in Morelos are: nativity scene, gerbera, geranium, chrysanthemum, poinsettia, cradle of bassinet, petunia, vinca, azalea, gardenia, lantana, daisy, rose and flare, on the other hand, ornamental trees stand out as: ficus, lemon cedar, laurel, tabachin, cypress and pine (PECI, 2008).

The genus Pelargonium belongs to the family Geraneaceae and has about 300 species of annual, biennial and perennial plants frequently used in gardening for its attractive flowers and its characteristic aroma. It includes plants with stems sometimes succulent or thickened. The leaves are alternate, pinnate or webbed, simple or compound, generally lobed or dentate and sometimes give off a pleasant aroma when squeezed. The petiole is usually long and the flowers are arranged in false umbels. The corolla has five free petals, two of them often larger than the rest. Adult stems tend to lignify (Ruiz-Fernández and López-Cuadrado, 2006).

It is a crop that requires light and ventilation for good vegetative development and abundant flowering. The temperature should be between 16 °C and 22 °C during the day and not fall below 12 °C during the night since the growth is markedly reduced. It is a very resistant species to the drought and it does not support the frosts. There are many varieties on the market differentiated by the color and type of flower, as well as by the vigor, color and pattern of the leaves (López-Cuadrado *et al*., 2006).

An agricultural substrate is defined as any material that has specific characteristics suitable for the production of containerized crops, on a large scale and with high quality (Acosta-Durán, 2008). Substrates are one of the factors that must be optimized to produce quality plants. The substrate is the support of the plant, but it is also the medium where complex chemical reactions are carried out prior to the absorption of water and nutrients by the roots; this activity is greater in the colloidal fraction of the soil (clays) and in the organic matter, hence the basis of most of the prepared substrates, being the organic matter, excluding the clays due to their deficient drainage. A limiting factor for the production of plants in containers is the substrate (Acosta-Durán, 2012).

The physical and chemical characteristics determine the quality of the substrate, so it is important to know them before choosing to use any. The most relevant physical characteristics are mainly the percentage of moisture retention, the percentage of porosity and the density. The main chemical characteristics are pH and electrical conductivity (Acosta-Durán, 2012).

The forest land is one of the main substrates used in the production of ornamental plants in the central region of Mexico (Bastida-Tapia, 2002), due to its physical characteristics, its availability and its low cost. However, the irrational exploitation of this resource has serious environmental impacts, mainly on the vegetation and soil of forest ecosystems. The land of forest is a material of extraction of the forest reason why its availability is limited by the law due to the negative ecological impact that takes place by the excessive exploitation. Thus, it is necessary to look for alternative materials for the preparation of substrates without losing the quality of the production of plants in containers (Acosta-Durán *et al*., 2007).

Among the materials that can replace the land of mount as a substrate, is the use of waste materials such as green garbage, which can be used for container production of ornamental species of economic importance.

The green garbage

Landscaping waste from public and private areas, also called “green garbage”, is produced in large quantities and municipal authorities are having problems getting rid of them. This material has a great potential for composting and produces a high fertility material with excellent physical properties to be used as a substrate component in the production of containerized plants. Green waste is a stabilized material although it is not completely composted so its effect could be variable throughout the cultivation period.

Studies have been carried out in other countries to stabilize the composted material but it is necessary to validate techniques for adoption purposes to be applied to the conditions of our region Masaguer *et al*. (2003) in a work where they used compost of garden waste showed that this can be a replacement alternative of the soil with perlite, since it is very economical, it does not contain additives and it is of direct use, besides reducing the use of resources not renewable.

Benito *et al*. (2006) studied the physical and chemical characteristics of substrates made from composted green waste and determined average pH values of 8, very high cation exchange capacity, values of C/N between 22 and 48, which is higher than the levels optimal from 15 to 20 and when compared with peat, it proved to be an acceptable material as a substrate for growing ornamental plants in containers.

Other reports report that the green waste composted, could be used as a unique substrate in the cultivation of ornamental species and represents a very interesting technological resource because it is economical, recycled, and also contributes to preserve the environment, since it is obtained from waste of pruning and reduces the amount of materials buried in sanitary landfills extending its useful life and may reduce the use of other resources such as peat, whose extraction harms the ecosystem (Vanier *et al*., 2011).

Barbaro *et al*. (2009) evaluated the performance of coral plants (*Salvia splendens*) grown on substrates formulated with composted pruning waste and soil and with different levels of fertilization with N-P-K. After the experience, they observed a major radical system, compared to commercial substrates.

López-Cuadrado *et al*. (2006) evaluated the effect of pruning residues as a substrate in the container culture of *Osteospermun ecklonis* as an indicative ornamental plant and it was found that the initial characterization of substrates made from pruning residues shows high values of electrical conductivity and N content, which results in a greater rooting. This later repelled a greater vegetal production. In addition, this substrate significantly reduced the consumption of peat without altering its agronomic behavior, therefore, it is a viable substrate for the cultivation of ornamental plants. Krucker *et al.* (2010) found good results when using composted organic materials such as garden waste, animal waste, biosolids, agricultural residues, wood shavings, municipal solid waste and food waste. These materials are characterized by high density, high salinity, low pH and low available water capacity.

They observed that these materials are good substrates, of acceptable quality for containers, that can be used when composting, supplying nutrients and producing plants of equal or better quality in growth, compared with standard substrates.

Due to the above, there is the possibility that the inclusion of green waste as a substrate component in the cultivation of containerized ornamental plants will have significant effects on the characteristics of their growth and development. Therefore, it was established as the objective of this work, to determine the physical and chemical characteristics of the “green waste” screened and to determine the optimum dose for its use as a substrate component for the production of containerized geranium.

Materials and methods

Physical chemical characterization of green waste

The green waste used in the experiment was donated by the collection center of the Autonomous University of the State of Morelos (UAEM), where it was prepared by grinding garden waste from the university and the ridges of the city of Cuernavaca, Morelos. The materials are mainly tree trimming waste such as ficus and grass cutting. It was chemically characterized to the green waste and the forest land alone and in the different mixtures used as treatments in the experiment that was conducted in the present work. The physical and chemical characterization was carried out in the agricultural production laboratory of the Faculty of Agricultural Sciences of the UAEM. The characteristics that were determined by the techniques described by Acosta-Duran (2012) were:

Moisture retention: calculated by the volume difference technique. It refers to the maximum volume of water that remains retained in the substrate after watering to container capacity and let drain freely. It is expressed as a percentage (%) of the volume of the material. This characteristic depends on the type of material and the particle size. Values between 40% and 60% are recommended for the adequate growth of most plants (Acosta-Duran, 2012).

Porosity: The percentage of porous space in dry conditions was calculated. It is the quantity of spaces that are not occupied by solid materials. It is expressed as a percentage of the total volume of the material. The characteristic basically depends on the particle size. Values of 45% to 75% are recommended for the good growth of plants (Acosta-Durán, 2012).

Apparent density: it was calculated with the method of the ratio of solid particles per unit volume.

Electric conductivity. It was measured directly in the substrate with a portable conductivity Hanna® mark with electrode floor. It is a measure used to determine the amount of salts present in the substrate. When there is excess of salts in the substrate there is water loss by the roots which causes visible symptoms and seriously damages the plants. It is expressed in Siemens per unit length. The reading units are usually: mS cm^{-1} (milliSiemens per centimeter) or dS m^{-1} (deciSiemens per meter).

pH: it was taken directly from the substrate with a potentiometer. It refers to the amount of free hydrogen ions in the substrate solution. It is described with a scale from 1 to 14, with the values between 5.5 and 7 being the most suitable for the cultivation of most species of plants in containers. This characteristic depends on the material and determines its acidity or alkalinity (Acosta-Durán, 2012).

Agronomic evaluation of green waste as a substrate component in containerized geranium cultivation

The experiment was conducted in the experimental field of the Autonomous University of the State of Morelos, located in Cuernavaca Morelos, which has a temperate climate, altitude of 1 820 meters above sea level and is located between the coordinates 9° 14’ 55’’ north latitude and the 18° 59’ 00’’ west longitude.

Crop management

A greenhouse of 300 m^2 covered with 50% phototrated plastic was used, with plastic covered floor. The 5 cm high seedlings were transplanted in 6’ black plastic containers that were previously filled with the mixtures of each of the treatments to be evaluated. The containers were irrigated every third day with hose up to container capacity and no fertilizers were applied during the cultivation cycle. At 30 days after the transplant (ddt), a pinch of the apical meristem was made to favor the radial growth of the plants, and all the inflorescences present at that moment were eliminated. The plants were kept in the greenhouse until 90 ddt.

Treatments

Different mixtures were made, in different proportions (v/v) of green garbage (BV) and earth of mount (TM), with a general substrate prepared with coconut fiber and pine sawdust (50%, v/v) to confer better conditions of moisture retention and porosity to the mixtures. The green waste was donated by the collection center of the UAEM. Before mixing them, the green garbage and the earth of mount were screened in particles of <2 cm. The proportions used in the mixtures were: 100%, 75%, 50% and 25%, complemented with the general substrate. The treatments were: BV100: 100% green waste; TM100: 100% forest land; BV75: 75% green waste and 25% general substrate; TM75: 75% of bush land and 25% of general substrate; BV50: 50% green waste and 50% general substrate; TM50: 50% of forest land and 50% of general substrate; BV25: 25% green waste and 75% general substrate; TM25: 25% of forest land and 75% of general substrate.

Experimental design

A completely randomized experimental design of eight treatments and eight repetitions with 64 experimental units was used. The experimental unit consisted of a container with a plant. The variance analysis was applied to the experimental results obtained through the SAS statistical program. To determine the differences between the means, the Tukey test was applied considering a level of significance of $p \leq 0.05$.

Response variables

The observed variables were the characteristics considered of growth and development of the plant under the following criteria: height of the plant (cm): the height of the plant was measured at 90 ddt from the base of the stem (substrate level) to the last sheet; diameter of the plant (cm): the largest diameter of the plant was measured at 90 ddt; diameter of the stem (mm): it was measured with the help of a digital vernier at the base of the stem (1 cm above the substrate level); number of leaves: this data was taken at the time of cutting, at 90 ddt for each plant of each treatment; number of flowers: this data was taken at the time of cutting, at 90 ddt for each plant of each treatment; chlorophyll content (SPAD): this data was taken from the highest leaf of each plant with a Minolta 503 equipment at 90 ddt; fresh weight of the stem and fresh weight of the root (g): it was obtained at 90 ddt, when weighing them on a digital scale immediately after removing them from the container, the roots were washed to remove traces of the substrate and immediately weighed; dry weight of the stem and the root (g): the shoots and roots were placed separately in paper bags, in an oven at 70 °C until they gave constant weight on a digital scale; root volume (ml): obtained by placing the roots in a test tube with clean water to measure the volume of water displaced; root length (cm): measured from its origin at the base of the stem to the tip of the longest root.

Results and discussion

Physical chemical characterization of green waste

The results obtained show that the physical and chemical properties of green garbage are very similar to those of the forest land, for example, in the percentage of porosity and moisture retention capacity, but in others, such as density, the pH and electrical conductivity are very different (Table 1).

Table 1. Physical-chemical characterization of substrates prepared with different proportions of green garbage, forest soil and general substrate, for the cultivation of containerized geranium.

Treatment	Physical characteristics			Chemical characteristics	
	Porosity (%)	Humidity retention (%)	Density (g L^{-1})	pH	Electric conductivity (dS m^{-1})
BV100	65	46.5	599	7.1	0.4
TM100	63	39.1	480	6.4	0.06
BV75	73	53.2	455	7.2	0.35
TM75	69.7	48.7	382	6.5	0.1
BV50	79.5	60.1	402	7.2	0.31
TM50	75.5	56	279	6.7	0.14
BV25	84.5	66.6	278	7.3	0.27
TM25	82	64.5	222	6.6	0.19

BV100= 100% green waste; TM100= 100% forest land; BV75= 75% green waste and 25% general substrate; TM75= 75% of bush land and 25% of general substrate; BV50= 50% green waste and 50% general substrate; TM50= 50% of bush land and 50% of general substrate; BV25= 25% green waste and 75% general substrate; TM25= 25% of scrubland and 75% of general substrate; general substrate= 50% coconut fiber and 50% pine sawdust.

It was also observed that, the greater the inclusion rate of green waste, the porosity and the moisture retention capacity decreased and the density and electrical conductivity increased.

Moisture retention capacity and porosity are properties that refer to the sufficient supply of water and air to the roots for growth. The minimum percentage of moisture retention capacity is 40-60%, in order to maintain a minimum of 15% of available water constant, while 50-70% is recommended for the percentage of porosity (Acosta Durán, 2012). The results showed that all the mixtures were above the minimum of the moisture retention and in the porosity the treatments with percentages of 75 and 100% of green garbage and forest land, were within the recommendable limits.

The density is the ratio between the dry weight and the volume of a dry substrate. The ideal density of a substrate varies between 200 and 900 g L^{-1} (Acosta-Durán, 2012). The results obtained in this physical property for all treatments, both green waste and forest land are within the ideal range for growing container plants.

The hydrogen potential is the concentration of H^+ ions in water and makes possible the availability of nutrients for the roots of plants. In crops without soil, the ideal pH ranges between 5.5 and 7.0 (Acosta-Durán, 2012). The results obtained for pH in all treatments with green waste range between 7.75 and 7.89; that is to say, they are slightly basic and instead, the pH in the treatments with earth of mount oscillate between 6.51 to 6.74, they are more acidic than the treatments with green waste.

The electrical conductivity is a measure equivalent to the capacity of cation exchange that indicates the capacity of a substrate to retain the cations that are in the nutrient solution. Ideal values vary between 0.76 and 1.25 dS m^{-1} for most containerized crops (Acosta-Durán, 2012). The results observed for the electrical conductivity are not within the ideal range, but the values shown by the treatments with green waste are greater than those shown by the treatments with forest land.

Agronomic evaluation

In general, significant differences were observed in all treatments, with the exception of stem diameter (Table 2). In almost all treatments with 100% green waste the results were statistically equal to those of 100% forest land, which indicates that the green waste works as a substrate that can replace the forest land for the cultivation of geranium in container, without causing differences in the development of the crop.

Table 2. Statistical comparison of the variables of eight treatments of green waste and forest soil in different doses as substrate components for the containerized geranium cultivation.

Treatment	Plant height (cm)	Plant diameter (cm)	Stem diameter (mm)	Num. of leaves	Chlorophyll content (spad)	Num. of flowers
BV100	18.9 a*	25.93 a	14.39 a	63.67 a	37 ab	3.5 a
TM100	18.28 a	23.92 ab	12.95 a	53 ab	44.08 a	3 abc
BV75	17.37 a	21.85 b	12.96 a	40.83 bc	39.58 ab	3 abc
TM75	18.47 a	21.4 b	12.88 a	51.17 ab	42.8 ab	3.67 a
BV50	19.72 a	23.87 ab	12.97 a	41 bc	37.67 ab	3.33 ab
TM50	16.28 ab	17.77 cd	12.37 a	36.5 bc	44 a	3.5 a
BV25	19 a	27.35 a	11.32 a	29.33 c	32.98 b	2.2 bc
TM25	12.25 b	13.82 d	12.18 a	24.33 c	40.65 ab	2 c
CV	13.99	9.2	15.11	27.09	13.84	22.48

*= in the columns, equal letters indicate that there are no significant differences (Tukey, $p < 0.05$); BV100= 100% green waste; TM100= 100% forest land; BV75= 75% green waste and 25% general substrate; TM75= 75% of bush land and 25% of general substrate; BV50= 50% green waste and 50% general substrate; TM50= 50% of bush land and 50% of general substrate; BV25= 25% green waste and 75% general substrate; TM25= 25% of bush land and 75% of general substrate.

At the height of the plant, no significant differences were observed in the treatments, except in the one of lower inclusion combined with forest soil (TM25), which indicates that green waste can be used in any of the previous doses as a substrate component. to obtain good results in the growth in height of geranium plant in container. In the diameter of the plant, significant differences were found between treatments, the BV100, TM100, BV50 and BV25 were statistically equal and superior to the rest.

There were no significant differences in stem diameter, which indicates that the proportions in the mixtures do not influence this variable. In the number of leaves, statistical differences were observed and the best treatments were BV100, TM100 and TM75, which were statistically equal to each other. In the chlorophyll content of the leaves, results similar to the number of leaves were observed. The number of flowers was statistically higher in the treatments to which they were added more than 50% of scrubland or green trash, which indicates that it is indistinct to use one or another material and that the results in the flowering of the plants they will be similar.

Vegetative growth is strongly influenced by the physical and chemical characteristics of the substrate, green waste is an element that can increase the capacity of moisture retention, pH and electrical conductivity, which translates into better nutrition conditions; therefore, plant growth. For the petunia cultivation in container, it was observed that with the inclusion of 30% compost based on manure and vegetable waste from the backyard as a substrate component, significantly improved variables such as stem diameter, flower production, leaves, shoots and production of total biomass (García-Albarado *et al*., 2010).

Barbaro *et al*. (2009) comparing levels of inclusion of compost from pruning residues with soil, found that the combination of 50-50 was superior to soil alone and to compost at 100% in stem diameter and plant height and the results were similar to the use of commercial substrate fertilized with 100 and 200 ppm of NPK. On the other hand, the number of flowers was higher than the pure compost substrate and in the commercial one.

In the aerial biomass, in the fresh weight the treatments BV100 and TM100 were statistically equal to each other and the BV100 was superior to the rest of the treatments and in dry weight of the stem, the treatments BV100, TM100 and TM75 were statistically equal to each other, but only the BV100 was superior to the rest of the treatments (Table 3). According to the results of Barbaro *et al.* (2009) in *Salvia splendens*, the treatments based on compost and soil obtained results in production of aerial biomass, comparable to the treatments with commercial substrate fertilized with 100 and 200 ppm of NPK, which shows that the compost could partially replace the substrate commercial. On the other hand, Masaguer *et al.* (2003) observed that the application of 50% compost of garden waste as a substrate component improved plant growth in cypress (*Cupressus sempervires*) surpassing the rest of the treatments.

Table 3. Statistical comparison for the variables of eight treatments of green waste and forest soil in different doses, as substrate components for the containerized geranium cultivation.

Treatment	Fresh weight of the stem (g)	Dry weight of the stem (g)	Root fresh weight of the root (g)	Root dry weight (g)	Root length (cm)	Volume of the root (mL)
BV100	46 a*	16.35 a	5.58 ab	4.75 ab	9.55 c	12.67 abcd
TM100	38.5 ab	15.2 ab	6.22 a	5.77 a	11.15 bc	15.33 ab
BV75	28.17 cd	10.43 bc	4.03 bcd	3.28 bc	12 ab	10.67 bcd
TM75	34.5 bc	14.58 ab	6.17 a	5.72 a	11.97 ab	16.5 a
BV50	35.67 bc	10.93 bc	4.27 bc	3.55 bc	11.37 abc	11.67 abcd
TM50	23.5 d	8.72 cd	4.87 ab	4.5 ab	11.65 abc	14.17 abc
BV25	19.67 de	7.4 cd	2.85 cd	2.65 c	13.8 a	9.67 cd
TM25	11.33 e	4.25 d	2.24 d	2.1 c	9.35 c	8.5 d
CV	15.66	28.4	21.44	20.63	12.23	23.81

*= in the columns, equal letters indicate that there are no significant differences (Tukey, $p< 0.05$); BV100= 100% green waste; TM100= 100% forest land; BV75= 75% green waste and 25% general substrate; TM75= 75% of bush land and 25% of general substrate; BV50= 50% green waste and 50% general substrate; TM50= 50% of bush land and 50% of general substrate; BV25= 25% green waste and 75% general substrate; TM25= 25% of bush land and 75% of general substrate.

The results also coincide from what was reported by Vendrame and Maguire (2005) who did a study in which they evaluated the effects of six different substrates on the growth of Petunia, Margarita, Daisy and Belen; the substrates were two commercial and one with 60% peat, 25% vermiculite and 15% perlite. The other three substrates contained different percentages of compost that contained biosolids and gardening pruning remains, where they found that the substrate that had 100% compost was the best treatment to increase the dry weight of the stem, on the commercial substrates made to peat base.

In fresh weight, dry weight and root volume, the best treatments were those that contained the highest amounts of green waste and scrubland (BV100 and TM100) that were statistically equal to each other and superior to the others; On the other hand, in the root length, the best treatments were those of percentages of 75 and 50 of green garbage and scrubland and that of BV25. These results can be explained by the porosity of the substrates, which with greater porosity generate an effect of thinner and longer roots. Other studies mention that the fresh and dry weight of the *Salvia spleendens* root did not improve in soil mixtures and pruning residue composts, but in substrates of 100% compost achieved the best result in root growth (Barbaro *et al*., 2009).

In another study to compare the effect of substrates with different proportions of organic materials (vermicompost) it was observed that the higher percentage of inclusion increased the height of the plant, stem diameter, dry stem weight, length and volume of root and the number and diameter of flowers of ageratum and petunia in container, surpassing the chemical fertilization treatment and concluding that the substrates with organic material can substitute the traditional substrates maintaining the quality of the cultures in container (Acosta-Durán *et al*., 2014). These responses can be explained because the addition of compost to the substrate significantly improves the contribution, absorption and nutritional accumulation of N, P, K, Ca and Mg in the different tissues of plants (Gómez-Merino *et al*., 2011).

In general, as mentioned by other authors, there are alternative materials that can replace conventional substrates, with similar and sometimes superior results, as is the case of the compost mix of pruning and soil waste (50-50, v/v). in *S. splendens* (Barbaro *et al*., 2009) that achieved phenological parameters very similar to those of the commercial substrate, but applying a 50% lower dose of fertilizer. The substrate made with compost of pruning remains could reduce the use of soil or peat by 50%. In trials with *Deutzia scabra*, the results were very favorable with inclusion percentages of less than 60% of the substrate mixture (Fisher and Pop, 1998).

Currently in Latin America regional materials are used for the preparation of substrates, although without precise knowledge of the physical and chemical properties of the same and research works are being developed that in the future will facilitate the use of alternative materials (Acosta-Durán *et al*., 2008). In this paper, the results clearly show that green waste and scrubland provide similar results in the growth and development of containerized geranium cultivation.

Conclusions

The green garbage has similar characteristics to the land of mount in percentage of porosity and capacity of retention of humidity, but in the density, the pH and the electrical conductivity, the green garbage has higher values.

In the growth and development of geranium in container, the green waste showed equal results to the forest land in 16 of the variables studied and was higher in seven of the variables studied.

The green waste is a material that used as a substrate has the physicochemical characteristics necessary to successfully replace the land of forest in the cultivation of containerized geranium.

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