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Use of alternative growing media in ornamental plants

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Abstract
Growing media is an organic or inorganic material that gives the root system anchorage to the plants. For plant metabolism, growth and development, it provides the necessary plant nutrients. Growing media is an integral part of most systems of horticultural development. Availability in large quantities along with its excellent preservation of air and water, low pH and salinity, and freedom from pests and diseases has led the growing media dominant in many parts of the world in the last 50 years. Several growing media, such as sand, peat, perlite, rock wool, sawdust, cocopeat, compost, etc., are found to be individually or in combination suitable for high-value crops such as gerbera, carnation, rose, orchids, Astroemeria, Lilium, etc. Maximum net benefit for ornamental crops can be achieved when different forms of growing media have been used because the growing media take a direct or indirect function in the growth of plants.

Keywords: Soilless media, cut flowers, loose flowers, potted plant, growing media

Introduction
Floriculture is a horticultural division which deals with the growing up and marketing of flower crops and ornamental plants. Floriculture has the commercial value with a considerable growth and a useful crop diversification option. India has now emerged as second largest flower production after china. More than 120 countries are active for floriculture production on large scale. Flowers also play a crucial role in human life by enhancing the environment and as a sign of emotions. The majority of perfumes used in the world come from jasmine and rose oils (Zeb *et al.*, 2007) [70].

Ornamentals are grown mainly for their aesthetic value, thus propagation and improvement of quality characters such as leaf types, flower color, fragrance, longevity and form, and architecture and the creation of unique variation are important economic goals for the ornamental industries (Kumar *et al.*, 2015) [37]. The scent of flowers in particular comes to our senses. We get relaxing, delicacy, calmness, harmony, heart opening, sensuality and love from it. Flowers are historically cultivated for the aesthetic, social role and extraction of essential oils and perfume production (Byczynski, 2008) [11].

Future climate change scenarios are expecting extreme conditions, such as drought and uneven precipitation distribution over the year (Abukari, 2016) [2]. A possible increase in water scarcity and extreme weather events may result in lower yields and higher yield variability (Olesen, 2002) [46]. These inconveniences will mainly occur in warmer areas all around the world. Therefore, in addition to provide adequate water, enhancing the efficiency of their sources will become increasingly necessary (Gruda *et al.*, 2019) [25, 26]. Agriculture producers are under pressure from a decrease in arable fields, increasing urbanization, water shortages and climate change. "Sustainable intensification," aimed at combining increased production without damaging the environment is a promising approach to tackling this issue (Raviv, 2017) [50].

The soil is the most available growing medium for good crop development, has some significant drawbacks, the existence of disease causing organisms and nematodes, unfavourable soil reactions, unfavourable soil compaction, poor drainage, erosion degradation, etc. which results in poor soil fertility, poor yield and quality of flower crops and ornamentals (Sengupta, 2012) [59]. Soilless culture is a method of growing plants in soilless media that helps to reduce the problems of traditional crop cultivation related to soil (Murumkar *et al.*, 2012) [45]. Soilless culture is characterised as plant cultivation in *in situ* systems without soil (Gruda *et al.*, 2017) [25, 26].

Soilless culture is the practice of growing plants with their roots submerged in nutrient solution in a soilless environment (Maharana and Koul, 2011) [39]. In protected agriculture, the Soilless culture system has been widely introduced to improve the growing climate and provide optimal supply of water and nutrients for cultivated crops (Putra, 2015) [49]. For example, soilless cultivation is the main cultivation method used in the Netherlands and Almeria, Spain (Lorenzo *et al.*, 2013) [38]. Soilless culture can potentially improve cropping systems by optimizing the use of inputs such as nutrients, pesticides and water, controlling diseases more efficiently and make it possible to increase crop production regardless of the climatic condition (Motagne *et al.*, 2015). The structure of soilless substrates has a major influence on plant physiology, yield and fruit quality (Alsmairat *et al.*, 2018) [3]. In protected agriculture, pest and disease accumulation in soil and water availability have always been an issue, and the use of soilless culture can be one of the alternatives to solve soil problems to improve water quality (Fandi *et al.*, 2010) [18].

Growing media has major role to support plants while holding nutrients, water for the plants to use during growth (Gohil *et al.*, 2018) [23]. The rooting and vegetative growth of the section was affected by media forms. Growing media should be considered as an essential part of the propagation system, because the rooting capacity depends on the type of medium used. The rooting medium directly affects the quality and the rooting percentage (Farooq, 2018) [19]. Good growth media are known to provide a reservoir for plant nutrients, keep plant water available, and provide the plants with a means to exchange gas and good anchorage (Galavi, 2013) [21]. The selected components to make the growing mix will have an impact on its physical and chemical properties. There are two types of growing media for potted plants they are:

A. Soil media

Soil is the basic media for plant. It is easy to handle and cheaply available. Generally most soils are composed of 50% air and water, 46-49% mineral particles and 1-6% organic matter. The mineral particle of soil or sand 0.05 - 2 mm, silt 0.002 - 0.05 mm and clay less than 0.002 mm. (Gohil *et al.*, 2018) [23]. Soil is a major habitat for both producers (green plants) and decomposers (bacteria and mushrooms). While with regard to most inorganic contaminants, air and water are both self-purifying systems, soil is a sink that is absorbed or filtered by the environment and can retain natural water materials that enter it. Soil also functions as the recycling device of nature, provides shelter for a multitude of living organisms and habitats constructed by human beings, and acts as an engineering medium (Karlen *et al.*, 1997) [33].

B. Soilless media

I. Organic growing media

1. Peat

It is one of the most used components of potting mixes. The upper and younger layer of a peat land is called “white peat” and lower layers of peat are called “Black peat”. It has high water holding capacity, attractive uniform, easy to handle and is commonly free of weeds and pathogens (Gohil *et al.*, 2018) [23]. Peat is derived primarily from plants and is focused on bio-decomposed matter. It consists of nutrient and oxygen deficiency accumulation, acidity and water logging conditions. At low temperatures, such as subarctic and boreal zones, the peat is mostly composed of mosses, shrubs, small trees and herbs, decreasing the decomposition ratio (Joosten and Clarke, 2002) [32]. It has a major structural feature that, even under heavy use is long-standing and biodegradable (Robertson, 1993) [52].

2. Sphagnum moss

It is produced by the genus sphagnum from dehydrated acid bog plants. It is lightweight and has the ability to absorb water 10-20 times its weight. Sphagnum moss has ability to inhibit a damping off the seedling because it contains specific fungistatic substances. It is used to cover seeds because it controls the disease and light weight (Gohil *et al.*, 2018) [23].

3. Shredded bark

This type of plant material from pine, cedar, fir and red wood can be used for raising ornamental plants. The growing medium consisting of pine bark can be used to raise a few terrestrial orchids successfully. The nutrients can be derived from the breakdown products of these organic materials (Gohil *et al.*, 2018) [23].

4. Coco peat

It is believed to be a byproduct of processing coconut husks as coir dust, coco peat, coir pith or simply coir. Coir is a flexible natural fibre derived from mesocarp tissue or coconut husk. It is natural soilless growing medium. It has high water holding capacity about 8-9 times of weight. The use of sphagnum peat as a renewable substitute in horticulture was considered (Yau and Murphy, 2000) [69]. It has physical characteristics, a high total pore space, high water content, low shrinkage, low mass density and slow biodegradability (Evans *et al.*, 1996) [17]. The properties of coconut peat are resistant to bacterial and fungal growth and have high oxygenation properties that are useful for healthy root production. Coir has nitrogen, calcium and magnesium, but phosphorus and potassium are comparatively high (Gohil *et al.*, 2018) [23].

5. Compost

Composting is a process of getting well decomposed organic matter from biodegradable organic waste under aerobic /anaerobic condition or converted to humus by indigenous microflora including fungi actinomyceties and bacteria. It is a rich or porous potting medium and has humidity with absorbent content and soluble minerals. It helps to provide nutrients to the plants. A disadvantage of compost is cost effective to transport due to bulky and weight and compared to chemical fertilizers nutrient value of compost is low (Gohil *et al.*, 2018) [23].

6. Vermicompost

End result of organic matter breakdown by earthworm, also known as worm humus, worm manure/worm casting. The compost is odourless. It is a clean organic material with sufficient amounts of N, P, K and many micronutrients that are important for the growth of plants. It helps boost the shape, texture, aeration and water holding ability of growing media. Vermicompost is rich in beneficial microorganisms. Vermicompost is important for sprouting and germination of bulb and seeds because it contains plant growth regulators like auxin and gibberellins (Gohil *et al.*, 2018) [23].

7. Leaf mould

It is the product of slow decomposition of shrubs and tree leaves by fungal breakdown. It increases water retention in pot by over 50%. Oak maple like tree species is suitable to

produce leaf mould. The properties are it has very low bulk density 0.1-0.25 g/cm3 (Gohil *et al.*, 2018) [23].

II) Inorganic growing media

1. Sand

Sand used in potting mix has important effects due to particle sizes of sand. The naturally occurring granular material consists of finely divided particles of rock and minerals. Its diameter ranges from 0.06mm-2mm. Silica (Silicon dioxide, SiO2), usually in the form of quartz, is the most common sand compound. It increases the water holding capacity and aeration and sand may be used to increase weight of the mix (Gohil *et al.*, 2018) [23].

2. Charcoal

Charcoal is the result of slow combustion of natural wood in the absence of oxygen to avoid combustion. Burning occurs at temperature of 400˚C to 500˚C (750˚ F -930˚F). It keeps nutrients in the soil so it increases soil fertility. It plays a crucial role in avoiding degradation for thousands of years in the soil and can bear it. It also helps the air to flow into the potting mix (Gohil *et al.*, 2018) [23].

3. Perlite

Perlite is origin of grayish-white silicaceous volcanic rock, mined from lava flows. It improves drainage and aeration in the mix. It is free from disease and weeds. Perlite is odourless, clean and simple to use and its pH is almost neutral. Disadvantages of perlite is contains very less nutrient and cation exchange capacity is very low (Gohil *et al.*, 2018) [23].

4. Vermiculite

Vermiculite is a natural micaceous mineral that expands when heat is applied. This is hydrated magnesium, aluminium-iron silicate by chemically. It increases the water and nutrient retention. Vermiculate is a light weight and sterile. The vermiculite often mixed with perlite while used in hydroponics (Gohil *et al.*, 2018) [23].

5. Rock

It is a horticultural medium made of rock and chalk as a natural ingredient. It is heated at 1600˚C, into lava after that rock wool fiber are spun, they are converted into mats by compressing which can be cut into cubes or slabs for hydro growing. It maintains physical property long time and with successive crops. It is light weight so easy to handle and to transport. Once fully irrigated however it becomes heavy and provides stability to the crops. These rock wool growing slabs or cubes are always ready-to-use for planting but it needs to be wet thoroughly (Gohil *et al.*, 2018) [23].

6. Jiffy

Nowadays it is specially prepared growing media. Jiffy is small decomposable pots made up of peat pellet in which seedling are grown (Robinson, 1975) [53]. Seedlings are grown in jiffy are directly transplanted into fields, where they very quickly decomposed and do not restrict root proliferation. It is generally a circular block diameter about 3-4 cm and ½ to 1 cm thickness enclosed in a net, actually which is not visible at the first glance, it has good capacity to absorb moisture and usually olive green to brown in color (Gohil *et al.*, 2018) [23].

Innovative types of growing media

The soil that provides nutrients, water, air and, above all, provides anchorage for good plant growth is the most available growing medium for plants. However, some of the severe limitations to plant growth are unfavourable soil composition, soil erosion causing depletion, inadequate drainage, improper soil reaction, the presence of disease-causing organisms and nematodes (Dholwani *et al.*, 2018) [15]. The hydroponics method of cultivation was applied to agriculture to remove these limitations. "Soilless culture is said to be any technique in which plants are grown without using soil as a rooting medium and necessary nutrients can be provided by water from irrigation." Fertilizers (containing nutrients) are supplied in a sufficient quantity by dissolving them in the irrigation water (Savvas, 2003) [26, 57]. Soilless farming can be categorized according to the techniques used. It is normally divided into two groups, the culture of substrates and the culture of water (Olubanjo and Alade, 2018) [47]. Hydroponics is one of the soil-free culture systems. In Greek, the term "hydroponics" derives from the terms "hydro" meaning water and "ponos" meaning labour (Sardare and Admane, 2013) [56]. Initially, only three varieties of crops were cultivated before hydroponics was commercially used: tomatoes, lettuce and herbs. A wide variety of crops, such as peppers, tomatoes, cucumbers, potatoes, roses, are now successfully grown hydroponically (El-Ramady, 2014) [16]. A particular class of gels is synthetic hydrophilic polymers (hydrogels) which are obtained in a three-dimensional network by chemical stabilisation of hydrophilic polymers. In terms of weight, hydrogels are characterised by the ability to absorb and retain liquid volumes (swelling) that are much greater than the initial weight of the material (Horie *et al.*, 2004) [29]. As soil improvers, hydrogels have been used effectively to increase the ability of sandy soils to retain water and/or conserve nutrients, with a potential decrease in irrigation frequency, compaction tendency and run-off of water (Abd El-Rehim, 2004). As slow release fertilisers, hydrogels have found uses (Teodorescu, 2009) [64]. A by-product of sugarcane bagasse conversion is sugarcane bagasse ash (SBA). The proportion of ash extracted from bagasse is generally a small percentage, between 1.5 and 3.0 percent by weight, of the original sugar cane bagasse, depending on the source of the sugar cane, the processing methods and the thermoconversion efficiency of the mill (Amin, 2011 and Garcia-Perez *et al.*, 2002) [4]. And Compared to other agricultural sources such as rice straw, 14.5 percent (Guo *et al.*, 2009) [27, 28] and wheat straw, 8.6 percent (Biricik *et al.*, 1999) [7], while SBA content is low (1.5-3.0 percent), the large amount of bagasse used for fuel results in vast amounts of SBA that need to be treated economically and environmentally. Biochar, a by-product of biomass pyrolysis rich in carbon, has the ability to replace PM as a greenhouse growing medium (Guo *et al.*, 2018) [27, 28]. In most greenhouse experiments, biochar obtained from lignin-based materials with adequate properties for plant growth has been used (Tian *et al.*, 2012) [65]. Zelkovaserrata seedlings showed better performance than the control in a containerized production system by integrating biochar made of woodchips of Japanese red pine (*Pinus densiflora)* and Sawtooth oak (*Quercus acutissima)* and rice husk at 20 percent (by vol.) with increasing media; Biochar made of crab shell, however had adverse effects on seedling growth (Cho *et al.*, 2017).

Use of growing media in ornamental plants

1. Use of growing media in potted plants

Potted plants are the only category of plants that can provide freshness even in small spaces and are a good source of reducing indoor air pollution (Jones, 1999) [31]. For the quality

production of flowers in floriculture, the most important factors are potting soil mixes. Ornamental floral species tend to have greater global demand, depending on the preferences of people (Kashihara, 2011) [34]. The biological and physico-chemical properties of a potting medium affect the growth of plants and roots (Abebe, 2017) [1]. Peat is the most widely used substrate for growing potted plants in nurseries and accounts for a large part of the material used for the processing of potted plants (Ribeiro *et al.,* 2007) [51]. The correct combination of growing media substrates to maximise plant growth is demanding and represents approximately 4-6% of cost output for bedding plants (Khan *et al.,* 2012) [36]. Potting media has a beneficial effect on disease conditions (Bulluck *et al.,* 2002) [10]. Roses are a type of miniature roses which have a smaller mass. They are usually grown to around 35 centimetres and are ideal for glass boxes, pots and containers and can have double or semi-double flowers (Cushman *et al.,* 1994) [13]. When leaf compost is used in growth media with nitrogen fertiliser, the media has a substantial effect on plant growth (Worrall, 1981) [68].

2. For flower plant nursery

The development of ornamental plant nurseries is one of the most specialised examples of intensive agriculture, with the large use of non-renewable resources to maximise plant growth and minimise production time in an attempt to capitalise on income from sales. As a result of this the "green industry" is also called a non-point (or diffuse) polluting industry due to the low efficiency of management practises. The cost of the substrate affects the total production cost of the potted plants by up to 12-15 percent in Italian ornamental nurseries (Lucia *et al,* 2009) [14]. Organic compost wastes that are properly mixed can produce excellent substrates for vegetable transplants (Verdonck, 1988) [67]. And (Gouin, 1993) [24]. Because of its extensive growth, particularly sewage sludge. Composting turns waste sludge into a drier, more homogeneous and biologically stable material that is potentially suitable for rooting plants and rich in plant nutrients (Mancini, 2011) [40]. However the proportion of compost in the final substrate is often very important in order to minimise potential hazards due to the presence of heavy metals and pathogens. Combinations of peat with sewage sludge manure and other materials can minimise the negative properties of single materials (high salinity, heterogeneity and contaminants) (Perez-Murcia *et al.,* 2006) [48].

3. Use of growing media in cut flower

In the growth and quality of pot plants, growing media often plays a vital role. Rose is one such traditional plant that requires a good medium for enhanced growth and quality of flower production. The nutritional status, water holding capacity and aeration, which determine the growth rate as reported by Sekar and Sujata (2001) [58], are determined by physiochemical properties of growing media. Gerbera grows well in substrates such as coconut peat, peat, sawdust, vermicompost, perlite, etc. Gerbera development can be further enhanced and strengthened by increasing in substrate culture. Brendert and Schmidt (1982) [9], argued that plants with higher water requirements were growing more vigorously in the leaf mould medium. Maldonado (1984), [20] found that in leaf mould medium, the plant height and leaf development of foliage plants were best. In the leaf mould, indicated by Khan and Khan (1991), [35] the bulb of Dahlia was best shaped. Aquila and Pasini (1989), [5] observed maximum plant height and number of leaves in plants grown in the leaf mould medium. In many countries and regions around the world, soilless culture has proven to be a viable alternative for the cut flower market, so soilless production for carnation has been implemented with very good results; higher yield and better quality (Metwally *et al.,* 2005). [42] Naveen. E. and Metwally (2013), [41] concluded that perlite: peat moss 1:1 v/v (PP) can be reported as the most appropriate growing medium for the development of protected carnation flowers in Egypt with high yield, flower quality, maximum efficiency of water and fertiliser use and could be regarded as a good investment from an economic point of view. Through a soilless culture method, Chrysanthemum production is possible. Cut chrysanthemum production on the bench system was more than 50 percent higher in productivity compared to soil bed production (Morgan *et al.,* 1981). [44] Several studies have shown that the soilless method would increase chrysanthemum yield, but the cost of investment and development was much higher, reducing the economic potential (Van Os *et al.,* 2008). In comparison with soil cultivation, Blok and Vermeulen (2010), [8] recently established a chrysanthemum growing method in the sand base system, peat base system and cassette base system. They noticed that they were all unprofitable structures.

4. Use of growing media in loose flower

Arancon *et al.,* (2008), [6] reported that the use of vermicompost has resulted in increased petunia plant germination, growth and flowering. Sangwan *et al.,* (2010), [54] conducted a pot culture experiment to assess the quality of marigold growth and vermicompost productivity produced from filter cake mixed with cow and horse dung. The Filter cake, cow dung and horse dung vermicompost have a higher manure benefit and have a synergistic impact on crop growth and productivity. The effect of vermicompost and chemical fertiliser on Rosemary (*Rosmarinus officinalis* L.) growth, herbal, oil yield, nutrient uptake, soil fertility, and oil quality was studied by Singh and Wasnik (2013). [60] Results found that vermicompost application (8 t ha-1)? Nitrogen (N)-phosphorus (P)-potassium (K) fertiliser (150:25:25 kg ha-1) produced optimum rosemary herbage and oil yield compared with control (no fertiliser) and was found to be on par with the application of NPK 300:50:50 k fertilizer. Sreerama *et al.,* (1999), [63] found that in cocopeat the root length of the plants is significantly higher than in other media in chrysanthemum cv. Sunny Reagan. Saravanan (2001), [55] has identified Dendrobium Hybrid CV. Sonia-17 recorded maximum plant height, number of roots per plant, earliness, number of spikes per plant, and spike length in coconut dust media. Sreerama *et al.,* (2002), [62] noted that under cocopeat medium, the carnation cultivar 'Malaga' reported maximum rooting (50.24 percent) and root length (1.15 cm). Sreenivas and Gowda (1999), [61] considered that the use of vermicompost and FYM with the prescribed dose of NPK increased the height of the plant, the number of leaves, the number of branches and the yield of the Chinese aster flower. Chauhan *et al.,* (2005), [12] reported that in that marigold cv. Pusa Narangi Gainda announced that the application of vermicompost @1000 g / m2 had a higher yield of flowers (1757.76 g / m2) than the application of vermicompost @500 g / m2 (1429.00 g / m2) alone. The effect of various potting media on growth and flowering in Vanda was studied by Jawaharlal and his colleagues in 2001. [30] It was reported that Brick parts + coir dust provides better results in Vanda with vegetative and floral characteristics.

Conclusion

Ornamental potting plant would be increasingly demanding in terms of its requirements for the highest standard of growing media. Soilless culture is the cultivation of plants that imitate soil-based gardening by using a wide variety of growing media, such as inorganic, organic matter. Rising media and the availability of essential nutrients are the most effective means of promoting pot plant growth and quality. Due to the strong water holding capacity, aeration and additional use of nutrients, the use of rising media has proved successful in increasing production of floric plants. Several growing media, including sand, turkey, perlite, rockwool, sawdust, cocopeat, compost, etc, are found to be suitable for cultivation of high value crops, individually and in combination. However, most crops produce better results when cocopeat is used alone or together because of easy availability.

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