Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(2): 1056-1061
Received: 04-01-2020
Accepted: 07-02-2020

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Growing media in floriculture crops

Sapna Kaushal and Poonam Kumari

Abstract
Use of growing media is proved effective for higher production of horticultural crops, due to their good water holding capacity, aeration and more uptake of nutrients. A good quality growing media plays an important role for obtaining luxuriant vegetative growth as well as profused flowering in various ornamental crops. Several growing media such as sand, peat, perlite, rockwool, sawdust, cocopeat, compost etc. singly or in combination are found suitable for growing high value crops like gerbera, carnation, rose, orchids, alstroemeria, lilium etc. Maximum net profit for ornamental crops can be obtained when various kind of growing media were used in combination with organic substrates because growing media play direct or indirect role in plant growth. Hence in this review article we have summarized the literature available on effect of various types of growing media in ornamental crops.

Keywords: Growing media, ornamental plants, growth, nutrient uptake

Introduction
Growing media is the material which is organic or inorganic provides anchorage to the plants by holding the root system. It provides the essential plant nutrients required for the metabolism, growth and development of the plants. Growing media are an integral part of most horticultural production systems. There is a wide range of media available, this leaflet considers the purpose of growing media and the qualities that growers should look for when selecting media for different purposes. Growing media are the substrates in which a plant will grow. They provide anchorage for the plant's roots, air spaces to allow respiration, and retain sufficient available water to enable plant growth. When selecting media, the grower needs to find the optimum balance between their requirements and those of the plants to be grown.

Criteria for selecting media
- Serves as reservoir of plant nutrients.
- Sufficiently firm enough to encourage or support the plants.
- Provides aeration for exchange of gases.
- Should not shrink or expand easily.
- Should have good drainage, porosity, aeration, etc.
- Should be easily available and economic.
- Should be sterilized easily.
- Free from pathogens, pests and weed seeds etc.

Desirable properties of growing media
1. Should possess high organic matter content that will not diminish quickly. The organic matter content should be more than 0.5%.
2. The carbon and nitrogen (C: N) ratio should be narrow (10:1 to 20:1) to facilitate high rate of decomposition
3. Optimum pH for soil based and soilless substrate is 6.2 to 6.8 and 5.4- 6.0
4. EC levels of 0.4 to 1.4 ds/m is optimum
4. Sufficiently porous to permit good aeration, mobility of water, root penetration as well as should retains enough water.
5. Should possess high cation exchange capacity for nutrient reserve (6-15 me/100cc).
6. Sufficient amendments and nutrients should be added to root substrate for better results
7. Medium should be free from weeds, nematodes, diseases and insects
8. Should be readily available or easily formulated within the acceptable cost

Types of growing media
1. Soil based media
2. Soil less media

Soil

Soil is the basic material/ ingredient of the media. It forms the major portion in the combination of different media. Soil is cheaply available, economic and easy to handle.

Most soils on the average are composed of 46-49% mineral particles (often called separates), 1-6% organic matter and 50% air and water. The mineral particles of soil are sand, silt and clay

Size and Characteristics of Soil Mineral Particles		
Mineral Particle	**Size**	**Characteristics**
Sand	0.05-2 mm	Relatively inert; small total surface area; forms large pores; increases drainage and aeration; poor nutrient holding capacity.
Silt	0.002-0.05 mm	Intermediate between sand and clay.
Clay	less than 0.002 mm	Chemically and structurally complex (negatively charged and laminated); large total surface area; forms very small pores; increases water and nutrient holding capacity; may decrease aeration and drainage if poor structure.

Soil less growing media

Soil less growing media is of two types:

1. Organic growing media (derived from living things i.e. plants)
2. Inorganic growing media (mined or man-made)

Organic growing media- Organic growing medium amendments usually are derived from plants or plant products that occur naturally (peat moss from peat bogs), or are the by-products of processing plants or mills (sawdust, cedar chips, bark, bagasse, rice hulls) or waste disposal plants (compost, processed sewage sludge, biosolids). The main purpose of using organic amendments is to loosen the soil and create large pores to increase. These media provides aeration, drainage, usable water holding capacity, nutrient holding capacity and decrease growing medium weight. (Kumari *et al*., 2017) [10]

1. Peat

Peat is obtained from remains of aquatic, marsh, bog, swamp vegetation found under water. It is formed when partially decomposed plants accumulate under water in areas with low temperatures and low oxygen and nutrient levels. The important property of peat are retaining moisture in soil when it's dry and preventing the excess of water from killing roots when it's wet. Peat has long been a favoured growing medium or constituent in mixed composts. It has excellent air and water holding qualities, is relatively uniform, attractive, safe to handle and is generally free of weeds and pathogens. Because it has been used for many years, the properties and performance of peat are well known and growers feel comfortable and confident when using it.

However, peat does have some disadvantages, particularly that it can shrink significantly if left to dry out too much, and will then be difficult to re-wet. Perhaps of more concern than potential production problems are the growing concerns about the environmental impacts of the use of peat. Peat takes many years to form and its use is far outstripping its regeneration. Most of the peat used in Wales is imported from Ireland, but increasing amounts are being sourced from Finland and the Baltic States. Peat based composts usually contain lime, nutrients, a wetting agent, sand, perlite, vermiculite and grit. The ratios of each component vary by purpose and brand.

Different types of Peat

A. Peat moss- Peat moss is most commonly used coarse grade peat in horticulture and it is derived from sphagnum or other mosses. Its colour varies from light tan to dark brown.

Peat moss has highest moisture holding capacity (about 60%) among various types and it decomposes slowly and contains 6-14% nitrogen. Peat moss is acidic in nature (3.2-4.5 pH), hence needs lime application (8-20 Kg/m^3).

B. Reed-Sedge peat- This peat is mainly derived from remains of grasses, reeds, sedges and other swamp plants and is reddish brown to almost black in colour. It is more decomposed than peat moss. Read-Sedge peat has leess water holding capacity and high in salt content and its pH varies from 4-7.5.

C. Peat humus- It is an advanced state of decomposition of either reed-sedge peat or hypnum mss. It is dark brown to black in colour and has less moisture holding capacity. It contains 2-3.5% nitrogen and pH varies from 5-7.5.

D. Sphagnum moss- Sphagnum moss is dehydrated remains of acid-bog plants from the genus Sphagnum and is commercially used horticulture peat. It is light in weight and has the ability to absorb 10 to 20 times its weight in water and pH ranges from 3.5-4.0. Sphagnum moss has high water holding capacity and is most desirable form of organic matter for the preparation of growing media. It possess fungi static substances which accounts for its ability to inhibit damping-off of seedlings.

2. Coco Peat

Cocopeat is also known as Coir Pith / Coco Peat / Coir Dust. Coir is a versatile natural fiber extracted from mesocarp tissue, or husk of the coconut fruit. The husk contains 20% to 30% fiber of varying length. After grinding the husk, the fibers are removed and used for preparation of coco- pith which is commonly used as medium. Cocopeat is the protective fibrous coating of the seed of the coconut palm. The coir fibre used in horticulture is the residue remaining after washing the long coir fibres which are used in rope and mat making. Coir fibre has very good aeration capacity and is used in composts as a bulking agent to increase moisture retention and porosity. Coir fibre is imported from tropical countries where it is considered a waste product.

Coco Peat holds 8-9 times its weight in water. It can be reused for up to 4 years. The properties of Coco Peat make it resistant to bacterial and fungal growth. It also extends the life of compost. Cocopeat provides the plants easy porosity for growing roots and good aeration for the healthy plant growth.

3. Compost

Compost is the well decomposed organic matter obtained by aerobic/anaerobic decomposition. Composting is a process of biodegradable organic wastes to stable humus by indigenous microflora including bacteria, fungi and actinomycetes.

Compost provides a rich growing medium, or a porous, absorbent material that holds moisture and soluble minerals. It also provides the support and nutrients to the plants.

4. Vermicompost

Vermicompost is also known as worm castings, worm humus or worm manure. Vermicompost is defined as the end-product of the breakdown of organic matter by the earthworm. The process of producing vermicompost by earthworms is called vermicomposting. This compost is an odorless, clean, organic material containing adequate quantities of N, P, K and several micronutrients essential for plant growth.

Nutrient status of vermicompost

Major nutrients (%)			Minor nutrients (ppm)			Micro-organisms (per gram)		
N	P	K	Cu	Fe	Zn	Fungi	Bacteria	Actinomycetes
2.5-3.0	1.0-1.5	1.5-2.0	52.0	930.0	186.6	$2.65x10^4$	$11.37x10^7$	$10.43x10^4$

(Purohit and Gehlot, 2006) [13]

5. Shredded bark/ wood bark

Small pieces of shredded bark from several woody species are used as component in growing and propagating media. It is mainly decomposed by heap method before use because fresh material contains phenols, resins, terpenes and tannins. Bark has long been a major component of growing media. Pine bark is the most commonly used. This has the advantage of being biologically active and suppressing some diseases. A disadvantage of bark is that it takes nitrogen from the growing medium as it decomposes.

- **Fir Bark** – most popular orchid potting medium. It is fairly light, easy to handle, rough surface and does not compact. Fir bark allowing air and water to be obtained by the plant's roots.
  Fir bark is mainly available in 3 grades:

a. Fine - Used for orchid seedlings or mature plants with fine roots.
b. Medium - Used for epiphytic orchids.
c. Coarse - Used for *Vanda*s and large *Phalaenopsis* orchids.

- **Redwood Bark** – similar to fir bark but is more resistant to decay. Since redwood bark is imported, it costs more than tree fern fiber. This bark is used more as an addition to potting mixes.

6. Leaf Mould

Leaf mould is a form of compost produced by the fungal breakdown of shrub and tree leaves. It is generally too dry, acidic, or low in nitrogen for bacterial decomposition. Leaf mould is essentially a soil conditioner. The addition of leaf mould increases water retention in soils by over 50%. It improves soil structure and provides a fantastic habitat for soil life, including earthworms and beneficial bacteria.
Maple, oak, and sycamore are among the principle leaf types suitable for the preparation of leaf mold. Layers of leaves and soil are composted together with small amounts of nitrogenous compounds for approximately 12 to 18 months. The use of leaf mold can effectively improve the aeration, drainage and water holding properties of a growing media. Although these materials are readily available at low cost, leaf mold is not extensively used in container production.

7. Bagasse

Bagasse is a waste bi-product of the sugar industry. It may be shredded and/or composted to produce a material which can increase the aeration and drainage properties of container media. Because of its high sugar content, rapid microbial activity results after the incorporation of bagasse into a media. This decreases the durability and longevity of bagasse and influences N levels. Although bagasse is readily available at low cost, (usually transportation), its use is limited.

8. Rice Hulls

Rice hulls are a biproduct of the rice milling industry. Although they are extremely light in weight, rice hulls are very effective at improving drainage. The particle size and resistance to decomposition of rice hulls and sawdust are very similar. However N depletion is not as serious of a problem in media amended with rice hulls.

Inorganic growing media

Inorganic substances are vermiculite, perlite, tire chunks, pea gravel and sand. In general, they must be bought, which makes them more expensive than organic amendments. Additionally, the industrial production process needs a great deal of energy. Therefore, these substances do not have the same degree of sustainability as organic amendments. Most are relatively sterile (with regard to plant pathogens) and many are relatively inert. Inorganic amendments are used to increase aeration, increase drainage, decrease excessive water holding capacity and decrease or increase weight (Reed D W, 2007) [15].

1. Sand

Sand is naturally occurring granular material composed of finely divided rock and mineral particles. Its diameter ranges from $1/16$ mm to 2 mm. Most common constituent of sand is silica (silicon dioxide, SiO_2), usually in the form of quartz. This may result in prohibitive transportation costs. Sand is a valuable amendment for both potting and propagation media.
Fine sands (0.05mm-0.25mm) do little to improve the physical properties of a growing media and may result in reduced drainage and aeration

Medium and coarse sand particles (1.00 mm) are those which provide optimum adjustments in media texture

2. Charcoal-

Charcoal is the blackish residue consisting of impure carbon obtained by removing water and other volatile constituents from animal and vegetation substances. Charcoal is produced by slow heating of wood, sugar, bone char or other substances in the absence of oxygen. The resulting soft, brittle, lightweight, black, porous material resembles coal and is 85% to 98% carbon with the remainder consisting of volatile chemicals and ash. It is commonly used as potting medium for growing Orchids.

3. Perlite

Perlite is a grayish-white silicaceous volcanic rock in origin, mined from lava flows. When heated to 1000 ^{0}C it expands to

about 13 times its original volume, then mineral particles pop like popcorn and form a granular, snow-white material that is so light in weight. Each particle of perlite is comprised of tiny closed air cells or bubbles. The surface of each particle is covered with tiny cavities which provide an extremely large surface area. These surface cavities trap moisture and make it available to plant roots. In addition, air passages are formed in the growing media thereby providing excellent aeration. Perlite is very dusty when dry and has a tendency to float to the top of a container during irrigation. It has also been shown that perlite contains potentially toxic levels of fluorine. Although costs are moderate, perlite is an effective amendment for growing media.

Advantages of Horticultural Perlite

- It improves Aeration and drainage.
- It makes moisture and nutrients readily available to plants.
- It has essentially neutral pH (6.5 to 7.5).
- It serves as an insulator to reduce extreme soil temperature fluctuations.
- It is sterile and free of weeds and disease.
- It is clean, odorless and safe to handle.
- It is light in weight (about 5 to 8 pounds per cubic foot (80-128 kg/m^3).

4. Vermiculite

Vermiculite is a natural micaceous mineral that expands with the application of heat. The expansion process is called exfoliation. Chemically it is hydrated magnesium, aluminium-iron silicate. Vermiculite is mainly formed from certain basaltic minerals. Vermiculite is a suitable growing medium for hydroponics and is good soil conditioner. Vermiculite has excellent exchange and buffering capacities as well as the ability to supply potassium and magnesium. Although vermiculite is less durable than sand and perlite, its chemical and physical properties are very desirable for container media.

Advantages of Vermiculite

- It has high water holding capacity.
- It is sterile in nature.
- It is suitable growing medium for hydroponics.
- It is good soil conditioner and is popular substrate for propagation and greenhouse cultivation.

5. Pumice

Pumice is a textural term for a volcanic rock that is a solidified frothy lava. Pumice is typically created when super-heated, highly pressurized rock is violently ejected from a volcano. It can be formed when lava and water are mixed. Chemically it is silicon oxide and aluminium oxide with small amount of Ca, Mg and Fe.

6. Rock-wool

Rockwool is a horticultural growing medium made from natural ingredients - basalt rock and chalk. Rock-wool for hydroponics is formed when heated at 1600 ^{0}C, into lava. The rock-wool lava is next blown through a large spinning chamber. It is pulled into fibers, which resemble cotton candy or the same lava fibers that fly around in a live volcano. After the rock-wool fibers are spun, they are compressed into mats that can be cut into slabs or cubes for hydro growing. It is mainly used in displays of cut flowers.

7. Polystyrene flakes

Polystyrene flakes, a bi-product of polystyrene processing, are highly resistant to decomposition, increase aeration and drainage, and decrease bulk density. Polystyrene may be broken down by high temperatures and by certain chemical disinfecting agents.

Flakes or beads of expanded polystyrene foam are added to media.it improve aeration, drainage and reduce cost. Styrofoam should not be steam heated. The beads can migrate to the top of the media and may become a nuisance if dispersed by water or wind. It supply no nutrients and pH is neutral.

Use of Growing media in ornamental plants

Growing media plays a very important role in growth and flowering of different cut flowers. Various researches have been done which shows the effect of growing media on various cut flowers. Thakur in 2005 [21] studied the effect of growing substrates on growth and flowering of Rose cv. 'First Red' under protected conditions. He concluded that G_3 (Soil: FYM: Cocopeat) gives better results in case of plant height, flower bud length, flower size and found to be at par with G_2 (Soil: FYM: Sawdust).

Jeong and his Co-workers in 2001 studied the use of recycled hydroponic Rockwool slabs for Hydroponic production of Cut Roses. They reported that T_8 (PURS 3 + PC 1) gives better results in all the parameters.

Reshma in 2002 [17] studied the effect of growing media on growth and flowering of Chrysanthemum (*Dendranthema grandiflorum*). She concluded that T_8 (Leafmould+Municipal Solid Waste) gives better result for growth and flowering of chrysanthemum.

Jhon and his co-workers in 2005 studied the effect of growing media on floral and bulb production characters in tulip cv. 'Apeldoorn' under polyhouse conditions. They reported that T_3 (Soil + Poultry manure + Sand) gives better result in case of scape length, stem thickness, no of bulbs per plant and vase life..

Rani and his co-workers studied the effect of growing media on various cultivars of *Lilium*. They concluded that Soil + Cocopeat gives earliest flowering, plant spread, bulb size and weight of bulblets, whereas soil also found to be at with Soil + cocopeat in case of earliest flowering and plant spread.

Dien in 2003 studied the effect of growing media under protected conditions in Gerbera under UHF Nauni, Solan conditions. He concluded that T_5 (Coco peat + Sawdust + Sand) gives better results for growth and flowering of gerbera and treatment T_3 (Coco peat + Sawdust) was found be at par with T_5 (Coco peat + Sawdust + Sand) in case yield of flowers.

Aswath and his co-workers in 2004 [2] studied the effect of growing medium in growth and flowering of *Gerbera jamesonii*. They concluded that T_1 (Coco peat + growing medium @ 100:0) gives better result in case of stalk thickness, stalk length and flower diameter whereas T_2 (Coco peat + growing medium @ 75:25) gives maximum number of flowers per plant.

Sekhar and Sujatha in 2001 studied the effect of media on flowering of gerbera cv. 'Mammut' under naturally ventilated green house. They concluded that treatment S_1 (Coir pith + Garden soil + FYM) gives better results for growth and flowering of Gerbera.

Barreto and his co-workers in 2006 [3] studied the Yield, quality and profitability of Gerbera cv. 'Sangria' as affected by different substrates. They reported that T_5 (Coco peat + Compost) gives better results in growth, flowering and yield of gerbera.

Tiwari and Kumar in 2011 studied the effect of growing media on growth and flowering of *Cymbidium*. They concluded that treatment T_1 (Pine Bark) gives better results for various growth and flowering characterstics of gerbera, whereas T_2 (Oak bark) was found to be at par with T_1 (Pine Bark).

Ali and his co-workers in 2011 [1] studied the Response of Freesia cultivars to different growing media under Peshawar conditions. They concluded that treatment T_3 (Mushroom compost) gives better results in growth and yield of freesia whereas treatment T_2 (Leaf mould) was found to be at par with T_3 (Mushroom compost).

Shivakumar and his co-workers in 2002 [19] studied the Effect of media composition on growth and flowering of Lisianthus (*Eustoma grandiflorus*). They reported that treatment M_3 (2 Coir Peat: 2 Sand: 1 Soil) gives better results for growth and flowering of Lisianthus.

Bhatia and his co-workers in 2004 studied the effect of growing media and fertilizers on growth and flowering in Carnation cv. 'Sunrise'. They concluded that G_2 F_3 (Soil + FYM + Coco peat (2:1:1), when fertigated with biofertilizers and water soluble fertilizers) gives better results for growth and flowering characterstics of carnation and G_2 F_1 (Soil + FYM + Coco peat (2:1:1), when fertigated with water soluble fertilizers) gives better results for number of flowers per plant.

Singh in 2013 [20] studied the effect of growing substrates on growth and flowering of *Alstroemeria hybrida* L. He concluded that T_3 (Rhododendron Forest Soil) gives better results in all the parameters of alstroemeria and T_4 (Cocopeat) also gives good results.

Latpate in 2011 [11] studied the effect of growing media on growth and flowering of *Hydrangea macrophylla* Thumb. He concluded that T_5 (Rhododendron: FYM: Sand) gives better results in all the vegetative and floral characterstics of hydrangea and T_3 (Rai: FYM: Sand) also gives better results.

Jawahar and his co-workers in 2001 studied the effect of various potting media on growth and flowering in Vanda. They reported that Brick pieces + coir dust gives better results for vegetative and floral characterstics in vanda.

Various growing media used for different floricultural crops

S.No.	Cut Flowers	Growing Media Used (In Different Combinations)	References
1.	Rose	Perlite, Zeolite and Cocopeat	Maloupa *et al*., 2001
2.	Rose	Rockwool, Pinewood chips, Particles of used rochwool	Jeong *et al*., 2001 [7]
3.	Vanda	Brick pieces, Charcoal, Coir dust	Jawaharlal *et al*., 2001 [9]
4.	*Dendranthema grandiflora*	Sand, Soil, FYM, Leafmould, Sawdust, Municipal solid waste	Reshma, 2002 [17]
5.	*Gladiolus x grandiflorus*	Sand, Silt, Clay, Leaf mould	Khan *et al*., 2002
6.	*Eustoma grandflorus*	Cocopeat, Sand, Soil	Shivakumar *et al*., 2002 [19]
7.	*Gerbera jamesonii*	Sand, Soil, FYM, Sawdust and Cocopeat	Dien, 2003
8.	*Dianthus caryophyllus*	Soil, FYM, Sand, Cocopeat, Sawdust	Suman *et al*., 2004 [4]
9.	*Gerbera jamesonii*	Coco peat + growing medium	Aswath *et al*., 2004 [2]
10.	Rose	Rockwool, Decomposed Sphagnum moss, Light Sphagnum moss	Sarakka *et al*., 2004
11.	Cut Roses	Soil, FYM, Sand, Cocopeat, Sawdust	Thakur, 2005 [21]
12.	Tulip	Soil, Saw dust, Poultry manure, Sheep manure	Jhon *et al*., 2005 [8]
13	Lilium	Soil and Cocopeat	Neerja *et al*., 2005
14	*Gerbera jamesonii*	Cocopeat, Perlite, Vermicompost, Compost, Rice husk	Barreto *et al*., 2006 [3]
15.	Oriental lily	Sand, Sawdust, Vermiculite, Moss	Sharma *et al*., 2007
16.	*Alstroemeria hybrid*	Sand, Soil, FYM, Perlite, Vermicompost, cocopeat	Gupta R and Gupta Y C, 2007
17.	Freesia	Leaf mould, Mushroom compost, Poultry manure, control	Ali *et al*., 2011 [1]
18.	*Cymbidium*	Pine bark, Oak bark and Rhododendron	Tiwari and Kumar, 2011 [22]
19.	Hydrangea macrophylla	Soil, Fym, Sand, Rai forest soil, Rhododendron, Chirpine	Latpate, 2011 [11]
20.	Cymbidium	Soil, sawdust, cocopeat	Barman *et al*., 2012
21.	*Alstroemeria hybrid*	Sand, Soil, FYM, Rhododendron forest soil, Rai forest soil	Singh, 2013 [20]

Conclusion

Use of growing media is proved effective for higher production of floricultural crops, due to their good water holding capacity, aeration and more uptake of nutrients. Several growing media such as sand, peat, perlite, rockwool, sawdust, cocopeat, compost etc. singly or in combination are found suitable for growing high value crops. But most of the crops gives better result when cocopeat is used alone or in combination due to easy availability.

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