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Effects of coir as a component of potting media on growth, flowering and physiological characteristics of hyacinth (*Hyacinthus orientalis* L. cv. Sonbol-e-Irani)

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Abstract

This study was conducted to investigate the effects of 15 different growing media consisted of coco peat (coir), soil and sand solely or in combination on hyacinth growth and flowering. Twenty two parameters including visual quality, flowering stem number, bulblet number, leaf number, leaf fresh and dry weights, flowering stem height and diameter, floret number, floret length, flowering stem fresh and dry weights, root fresh and dry weights, photosynthesis rate, stomatal conductance, mesophyll efficiency, water use efficiency, transpiration rate, chlorophyll content, quality index and pot weight were measured. Results indicated that growing media affected the measured traits. Parameters such as visual quality, leaf number, leaf fresh and dry weights, flowering stem height, bulblet number and root fresh and dry weights, were higher in the mixture containing equal amount of sand:coco peat compared to other media. The highest photosynthesis rate, mesophyll efficiency, flowering stem fresh weight and floret length were observed in the media containing only coco peat and the highest transpiration rate and stomatal conductance resulted from the medium consisted of only sand. The highest water use efficiency was obtained in soil/coco peat/sand (2:1:1) medium

Key words: bulbous plant, coco peat, photosynthesis rate, pot mixtures.

1. Introduction

Hyacinthus orientalis L. is an excellent garden plant and can be easily forced for use either as potted plant or as cut flower. It is well known for its intense fragrance [6]. The individual florets can also be used in corsage, wedding arrangement, and perfume industry, as well [7]. This flower with the Persian name "Sonbol" is also a popular garden and or pot plant which is widely used particularly for "Haftsin" in the traditional "Norouz" ceremony by Iranian people. Plants growing in containers have restricted availability of water and nutrients require correct irrigarion and fertilization. Therefore, growing media selected for container growing plants should provide specific plant requirements [7]. Substrates composed of materials such as peat moss (peat), bark, perlite, styrofoam, vermiculite, sand, rock wool, or natural field soils are typically utilized in greenhouse production of containerized crops [3,13]. Most greenhouse crops are grown in lightweight media, which are combination of two or more components of limited selection, formulated to achieve desirable chemical and physical properties. There is no optimum growing medium for all potted plants [9]. Coir dust is similar in appearance to peat moss and is a by-product of coconut (*Cocus nucifera* L.) husk fiber processing industry [8]. This organic material has been proposed as a possible alternative to peat in growth media due to its suitable physical and chemical properties. Coir has been tested as a horticulture medium for several ornamental and agronomic crops with acceptable results [2,16,8]. Soilless media have proven popular with the majority of producers because of consistency, excellent aeration, reproducibility, and low bulk

Table 1. Total pore space (TPS), bulk density (BD), water-holding capacity (WHC), pH and electrical conductivity (EC) of media used.

Medium	TPS (%)	BD (g cm-3)	WHC (% by wt)	pH	EC (dS m-1)
Coco peat	87.00a*	0.13c	715.00a	5.40b	1.24a
Sand	38.00b	1.60a	31.00c	7.50a	1.12a
Soil	56.00c	1.42b	46.00b	7.80a	0.90a

*In each column, means with the same letters are not significantly different at 5% level of probability using Tukey's test.

density that reduce shipping and handling costs of the medium itself and of the finished plants. To balance the low bulk density of many soilless mixes- in some situations- a component with high bulk density, such as sand or calcined clay, is needed [7]. Khayyat et al. [10] studied the effect of 22 pot mixtures on growth and development of pothos (*Epipremnum aureum* Lindl. and Andre 'Golden Pothos') and reported that parameters including freshness, shoot length, shoot fresh and dry weights, root fresh and dry weights and root number were higher in medium containing only coco peat. Talukdar and Barooah [17] reported that mixure of coconut fiber and mossinduces superior flowering of *Dendrobium densiflorum*. Selected physical and chemical properties of thirteen coconut coir wastes were evaluated as growing media or growing media constituents for containerized plants. Coir waste was evaluated as a lightweight material and showed a high total porosity, over 94 % (vol). Total water-holding capacity in coir waste was lower than peat. pH was slightly acidic and salinity varied between 0.4 and 6.0 dS m^{-1}. Cation exchange capacity ranged from 32 to 95 m.e./100 g and C/N ratios averaged 117 [14]. The growth and flowering of four annual ornamentals, namely zinnia (*Zinnia elegans*), celosia (*Celosia plumosa*), marigold (*Tagetes erecta*), and vinca (*Catharanthus roseus*) were evaluated at different growing media containing varying percentage of coconut dust and tropical peat. Higher proportion of coconut dust delayed plume emergence in celosia but they were longer than those grown in 100% peat. Marigold grown in coconut dust containing media produced more flowers [1]. Although, the effects of different pot mixtures on plant growth and development have previously been investigated, few reports are available in the case of bulbous plants. Hyacinth as a bulbous plant requires well drainage and good water availability. As the mentioned factors are very important particularly in pot culture, system soil amendments capable of meeting these requirements deserve study. The objective of this comparative study was to assess coir, sand and soil, alone and in combinations (15 media) on vegetative, reproductive and physiological characteristics of hyacinth (*Hyacinthus orientalis* L.).

2. Material and methods

The physical properties of growing media components were determined before planting (Table 1). The total pore space (TPS), bulk density (BD), and water-holding capacity (WHC) were measured according to the methods described by De Boodt and Verdonck [5]. The electrical conductivity (EC) and pH of substrate solutions were determined using EC Meter Metrohm model 644 and pH Meter Sartorius model pp-20, respectively.

2.1. Growth media

Fifteen pot mixtures were used for this experiment. The composition of these media by volume was as follows:

1. Soil
2. Coco peat
3. Sand
4. Sand/soil (1:1)
5. Coco peat/soil (1:1)
6. Coco peat/sand (1:1)
7. Coco peat/soil (1:3)
8. Sand/soil (1:3)
9. Coco peat/sand (3:1)
10. Coco peat/soil (3:1)
11. Soil/sand (1:3)
12. Coco peat/sand (1:3)
13. Soil/coco peat/sand (2:1:1)
14. Soil/coco peat/sand (1:2:1)
15. Soil/coco peat/sand (1:1:2)

2.2. Culture conditions, data recording and analysis

A greenhouse experiment was conducted during 2004 and 2005 on hyacinth 'Sonbol-e-Irani' with 36.44 g bulb weight in average. The pots (3 L plastic pots) were put outside from October to February under natural condition with the average temperature of 9.16°C to be forced naturally and in the middle on December transferred to greenhouse. Plants were monthly fertilized with a complete fertilizer (Rosasol Even) in concentration of 2 g L^{-1} and the pots were irrigated twice a week. Plants were maintained in greenhouse under natural light (>800 µmol m^{-2} s^{-1}) at a day temperature of 23±2°C and night temperature of 13±2°C and a RH of about 60±5%. A data measurement was carried out 20 days after transferring the pots to greenhouse until the end of flowering (until early February). Twenty two parameters including visual quality, flowering stem number, bulblet number, leaf number, leaf fresh and dry weights, flowering stem height and diameters, floret number, floret length, flowering stem fresh and dry weights, root fresh and dry weights, photosynthesis rate, stomatal conductance, mesophyll efficiency, water use efficiency, transpiration rate, chlorophyll content, quality index and pot weight were measured from the onset of flowering to the end of the experiment period when required. Photosynthesis rates (A_{net}, µmol m^{-2} s^{-1}), transpiration rate (mmol H_2O m^{-2} s^{-1}), and stomatal conductance (g_s,mol $m^{-2}s^{-1}$), were measured by portable photosynthesis meter (Lci, ADC) when the flowers were fully opened. Mesophyll efficiency

Table 2. The effects of pot mixtures on visual quality (VQ), leaf number (LN), leaf fresh weight (LFW), leaf dry weight (LDW), root fresh weight (RFW), root dry weight (RDW), pot weight (PW), bulblet number (BN), flowering stem height (FSH) and flowering stem number (FSN) of hyacinth 'Sonbol-e-Irani'.

Treatments	VQ	LN	LFW (g)	LDW (g)	RFW (g)	RDW (g)	PW (Kg)	BN	FSH (cm)	FSN
Soil	6.25cd*	12.00ef	22.58def	1.43cde	8.42def	0.82bcd	4.40a	0.53de	24.27bc	2.00a
Coco peat	9.70a	17.00bcd	38.60ab	2.35abc	14.37cde	1.21a-d	2.16f	3.50a	30.29ab	2.25a
Sand	5.25d	11.25ef	11.95g	0.86e	7.37ef	0.68cd	4.38a	0.50de	15.69d	1.75a
Sand/soil (1:1)	6.75bcd	9.25f	21.35d-g	1.37de	9.65def	1.12a-d	4.52a	0.25e	21.49cd	2.00a
Coco peat/soil (1:1)	8.25abc	24.50a	41.92a	2.44ab	28.55ab	1.95ab	3.04def	2.75ab	24.70bc	3.00a
Coco peat/sand (1:1)	9.75a	25.00a	43.33a	2.59a	33.12a	2.20a	3.25b-e	3.50a	31.77a	2.25a
Coco peat/sand (1:3)	8.48abc	18.00bcd	25.55c-f	1.63b-e	14.22cde	1.13abc	3.47a-d	1.00cde	26.00abc	2.25a
Sand/soil (1:3)	7.55a-d	13.75def	21.08efg	1.42cde	5.10f	0.52d	4.34a	0.50de	21.75cd	2.25a
Coco peat/sand (3:1)	9.68a	14.00cde	26.15c-f	1.73a-de	26.37ab	1.60a-d	2.74def	2.25abc	25.27bc	1.75a
Coco peat/soil (3:1)	9.30ab	17.75bcd	30.67b-e	1.97a-d	28.32ab	1.78abc	2.61ef	0.25e	24.69bc	2.00a
Soil/sand (1:3)	6.75bcd	15.00b-e	18.88fg	1.29de	9.97def	0.93bcd	4.29ab	0.25e	22.30c	2.00a
Coco peat/sand (1:3)	7.75a-d	16.75bcd	24.65c-f	1.71a-e	16.12cd	1.09a-d	3.93abc	0.25e	20.12cd	2.00a
Soil/coco peat/sand (2:1:1)	7.83a-d	18.75b	34.45abc	2.19a-d	26.68ab	1.90ab	3.55a-e	2.25abc	25.04bc	2.25a
Soil/coco peat/sand (1:2:1)	8.50abc	18.50bc	31.17bcd	2.23a-d	29.42a	1.92ab	3.15c-f	1.00cde	23.21c	2.75a
Soil/coco peat/sand (1:1:2)	7.75a-d	18.25bcd	29.85b-e	2.04a-d	21.00bc	1.58a-d	3.62a-e	1.75bcd	20.97cd	2.75a

*Explanations: see table 1.

Table 3. The effects of pot mixtures on flowering stem diameter (FSD), floret number (FN), floret length (FL), chlorophyll content (CHC), quality index (QI), flowering stem fresh weight (FSFW), flowering stem dry weight (FSDW) and transpiration rate (TR) of hyacinth 'Sonbol-e-Irani'.

Treatments	FSD (mm)	FN	FL (mm)	CHC (mg g^{-1} fw)	QI (g cm^{-1})	FSFW (g)	FSDW (g)	TR (mmol H_2O m^{-2} s^{-1})
Soil	2.80a*	5.00a	5.48ab	0.79ab	0.13a	3.59ab	0.26a	4.59e
Coco peat	3.45a	6.00a	6.84a	0.92a	0.16a	4.85a	0.33a	10.79ab
Sand	2.78a	5.75a	4.61b	0.73b	0.14a	2.22b	0.32a	11.21a
Sand/soil (1:1)	2.98a	5.52a	5.54ab	0.80ab	0.16a	3.48ab	0.33a	8.71abcd
Coco peat/soil (1:1)	2.45a	4.73a	5.72ab	0.90ab	0.13a	3.30ab	0.21a	10.49abc
Coco peat/sand (1:1)	2.85a	6.22a	6.16ab	0.83ab	0.15a	4.62a	0.30a	8.48bcd
Coco peat/sand (1:3)	2.19a	5.67a	5.35ab	0.88ab	0.13a	3.63ab	0.28a	10.84ab
Sand/soil (1:3)	2.76a	5.33a	4.80b	0.77ab	0.15a	3.29ab	0.26a	7.85d
Coco peat/sand (3:1)	3.04a	5.62a	5.84ab	0.87ab	0.16a	4.10ab	0.30a	7.93cd
Coco peat/soil (3:1)	2.81a	5.37a	5.63ab	0.92a	0.15a	3.68ab	0.25a	9.10a-d
Soil/sand (1:3)	2.73a	5.48a	5.47ab	0.75ab	0.14a	3.25ab	0.32a	10.71ab
Coco peat/sand (1:3)	2.69a	5.67a	4.73b	0.83ab	0.15a	3.34ab	0.29a	10.68ab
Soil/coco peat/sand (2:1:1)	2.97a	6.55a	5.10ab	0.85ab	0.15a	3.80ab	0.27a	7.60d
Soil/coco peat/sand (1:2:1)	2.71a	5.56a	5.20ab	0.86ab	0.16a	3.62ab	0.23a	9.74abcd
Soil/coco peat/sand (1:1:2)	2.98a	5.68a	5.10ab	0.85ab	0.16a	3.08ab	0.22a	10.04abcd

*Explanations: see table 1.

Table 4. The effects of pot mixtures on stomatal conductance, mesophyll efficiency, water use efficiency and photosynthesis rate of hyacinth 'Sonbol-e-Irani'.

Treatments	Stomatal conductance (mmol m^{-2} s^{-1})	Mesophyll efficiency (µmol m^{-2} s^{-1}/vpm)	Water use efficiency (µmol m^{-2} s^{-1} CO_2/ mmol m^{-2} s^{-1} H_2O)	Photosynthesis rate (µmol m^{-2} s^{-1})
Soil	0.24f*	0.05f	2.57abcd	11.59e
Coco peat	0.73bc	0.20a	3.84ab	41.35a
Sand	1.30a	0.16bcd	3.27abcd	36.75ab
Sand/soil (1:1)	0.53cde	0.12de	2.30bcd	25.54cd
Coco peat/soil (1:1)	0.53cde	0.18ab	3.68ab	37.86ab
Coco peat/sand (1:1)	0.40def	0.19ab	3.94ab	33.33abc
Coco peat/sand (1:3)	0.41def	0.07f	1.93cd	18.77de
Sand/soil (1:3)	0.29ef	0.05f	1.85d	14.37e
Coco peat/sand (3:1)	0.90b	0.16bcd	3.31a-d	33.13abc
Coco peat/soil (3:1)	0.75bc	0.14cde	3.51a-d	31.87bc
Soil/sand (1:3)	0.75bc	0.16bcd	2.93a-d	31.23bc
Coco peat/sand (1:3)	0.73bc	0.11e	2.39a-d	26.22cd
Soil/coco peat/sand (2:1:1)	0.31ef	0.17abc	4.09a	32.59bc
Soil/coco peat/sand (1:2:1)	0.60cd	0.16bcd	3.40a-d	33.39abc
Soil/coco peat/sand (1:1:2)	0.81bc	0.18ab	3.57abc	36.52ab

*Explanations: see table 1

(ME, µmol m^{-2} s^{-1} /vpm) and water use efficiency (WUE, µmol m^{-2} s^{-1} CO_2/mmol m^{-2} s^{-1} H_2O), were calculated by dividing the photosynthesis by sub-stomatal CO_2, and by dividing the photosynthesis by transpiration, respectively [11]. Measurements were conducted on clear sunny days between 10:00 AM and 01:00 PM (time of the highest photosynthesis rates). Quality index (g cm^{-1}) was calculated based on the fresh weight of flowering stem divided by its height [4]. To measure the dry weight of flowering stem, leaf, and root the materials were kept in an oven with the temperature of 75 °C for 48 hr. Visual quality as the freshness parameter was recorded after flowering of the plants using a ranking scale of 1 to 10, 1= not fresh and rigid shoot and flower; 10= ideal freshness and rigidity of the shoot and flower. Experiment was conducted in Completely Randomized Design (CRD) with 15 treatments, 4 replications (2 bulbs per pot) in each. Means were compared using Tukey's test at 5% level of probability.

3. Results

3.1. Vegetative growth

3.1.1. Visual quality, leaf number, leaf fresh and dry weights and chlorophyll content

The highest visual quality was observed in the media of coco peat/ sand (1:1). Lowest visual quality was observed in sand only treatment. Higher leaf number and leaf fresh and dry weights were observed in the media contained coco peat/ sand (1:1). Chlorophyll content was affected significantly among the treatments although it was higher in coco peat only and coco peat/soil (3:1) pot mixtures (Table 2 and 3).

3.1.2. Root fresh and dry weights, pot weight, and bulblet number

The highest root fresh (33.12 g) and dry (2.20 g) weights were observed in coco peat/sand (1:1), compared to the other pot mixtures. Lowest root fresh weight (5.10 g) and dry weight (0.52 g) was observed on plants grown on sand/soil (1:3) mixture. Lowest and highest pot weights were belonged to coco peat only and sand/soil (1:1) pot mixtures, respectively. The highest bulblet number was observed in coco peat only and coco peat/sand (1:1) mixtures (Table 2).

3.2. Flowering

3.2.1. Flowering stem height, number and diameter

No significant difference was observed among the treatments in the case of flowering stem number and diameter, but flowering stem height was affected significantly and the highest flowering stem height was observed in coco peat/sand (1:1) (Tables 2 and 3).

3.2.2. Floret number and floret length

The pot mixtures did not significantly affect floret number. The highest floret length was observed in coco peat only treatment (Table 3).

3.2.3. Quality index, flowering stem fresh and dry weights

Quality index and flowering stem dry weight were not significantly affected by the treatments and compared to the other pot mixtures. Higher flowering stem fresh weight was obtained in medium contained coco peat only and coco peat/sand (1:1), and the lowest flowering stem fresh weight was observed in sand only pot mixtures.

3.3. Physiological parameters

3.3.1. Transpiration and photosynthesis rate

The results in Table 3 show that pot mixture significantly affected transpiration rate. Higher transpiration rate was observed in the media containing sand only compared to the other treatments. The highest photosynthesis rate and mesophyll efficiency were observed in coco peat only treatment (Table 3 and 4).

3.3.2. Stomatal conductance, mesophyll efficiency and water use efficiency

Higher stomatal conductance was obtained in the media containing sand only and significant difference was observed between this medium and the other media. Results indicated that highest water use efficiency was observed in soil/cocopeat/sand (2:1:1) pot mixtures compared to other media (Table 4).

4. Discussion

The superiority of coco peat only and coco peat/sand (1:1) over the other combinations in this study may be related to coco peat characteristics including higher total pore space (TPS) and water holding capacity (WHC). However, some traits were not significantly different between these two media including visual quality, leaf fresh and dry weight, root dry weight, bulblet number, flower stem number, flowering stem height, flowering stem diameter, floret number and length, chlorophyll content, flowering stem fresh and dry weight, transpiration rate, photosynthetic rate, mesophyll efficiency and water use efficiency. Although, coco peat is a good moisture-retentive material, in most cases particularly bulbous plants, aeration is a prerequisite, as well. Thus, comparing these two media-coco peat solely and coco peat/sand (1:1) - the latter could be reasonably recommended since: 1) moisture availability and nutrition status of the medium is provided by coco peat and 2) aeration is provided by sand. The present results confirmed those reported by Khayyat et al. [10] which indicated the superiority of coco peat over other pot mixtures on pothos. The best yield of roses was also reported to obtain in coco peat included media [12]. The highest values of leaf area, leaf number, offset number, shoot and root fresh and dry weight and shoot length in pothos were observed in medium contained only coco peat as reported by Sameei et al. [15]. Some physiological characters such as photosynthetic rate and water use efficiency in this research were also improved by coco peat as amendment, most probably due to its valuable characteristics including TPS, WHC, and CEC. As pot weight is an important factor during forcing program and shipping, the lighter the pot weight, the easier the handling. Soil is not only heavy and prone to disease, but also may be compacted after potting. Although this research area needs more study based on the finding of this research and the similar previous

reports, coco peat could be recommended as an efficient substitution for soil in pot mixtures.

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