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Composted palm waste as an alternative of coco peat in growing media: effects on growth and nutritional status of Lily cut flower (*Lilium* spp.)

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ABSTRACT

Purpose: A greenhouse experiment was conducted to evaluate the effect of the mixture of different growing media (palm trunk: resulted from palm trunk only; palm tree: resulted from all palm organs; coco peat; perlite; reused coco peat) on growth and nutrient uptake of lily cut flower. **Research method:** Treatments including two cultivars (Tiber and Candy Club) and eleven growing media compositions were set up in a factorial experiment based on a completely randomized design. **Findings:** The Control showed the highest leaf surface area, bulb depletion rate, and Mg content, while the higher plant height and the leaves number were observed in 40% and 80% palm trunk treatments, respectively. Furthermore, the 40% palm trunk resulting in a higher Fe content. The highest bud's number, K, Cu, and Mn content measured in Candy Club, which was cultivated on 20% palm tree treatment, that increased by an average of 10.1%, 15.8%, 67.4%, and 54.3%, respectively compared to the control. The Candy Club has grown on control showed the highest values of the reproductive organ length, N, and P concentration. The highest Ca content was obtained after the Tiber's cultivation in the 80% palm trunk. **Research limitations:** No limitations were founded. **Originality/Value:** Because of the low cost, availability, and extensive cultivation area of date palm in Iran and over the world, palm wastes has a great potential to be used as an eco-friendly horticultural substrate mixture to substitute coco peat in lily soilless culture.

INTRODUCTION

One-third of the market value of ornamental plants belongs to cut flowers (Hajizadeh, 2016). Lily (*Lilium* spp.), a bulbous plant with large trumpet-shaped and typically fragrant flowers, is one of the most important ornamental plants worldwide. They are cultivated as flowering potted plants and cut flowers (Liao et al., 2012). Because of better control of plant nourishing and improvement of crop quality and quantity, greenhouse cultivation as well as off-season production of the crops is increasing. As the characteristics of growing media, directly and indirectly, influence the plant growth and productivity, selecting the appropriate growing media is one of the main factors that affect the success of soilless culture (Doaguie & Ghazanfari Moghadam, 2015). Organic media have unique physical and chemical characters compared to inorganic medium; for example, peat moss and pine bark act somewhat like soil because of their internal and surface absorption. Buffering capacity is another property of organic materials, which reduces the possibility of element deficiency or toxicity. Besides, organic materials contain some of the essential nutritional elements of plants (Gruda et al., 2013).

Coco peat or coconut fiber is one of the ingredients of growing media, abundant in tropical countries (Abad et al., 2002; Awang et al., 2009; 2010). It is a principal component of growing media in the tropics because of its availability and benefits (Abad et al., 2002; Awang et al., 2009). Since coco peat is produced from coconut plants, the production industry is limited to specific geographic areas. So; it is ordinarily costly for other countries to import and employ it in hydroponic culture (Dhen et al., 2018). Moreover, an increase in the production cost of potting plants and the possibility of introducing quarantine pests and diseases by the imported coco peat forces greenhouse growers to adopt more environment-friendly cultivation methods (Basirat, 2011; Massa et al., 2011). Finding the eco-friendly material (rapidly renewable, locally available with a low cost and able to perform as a commercial product) as an alternative to peat coco peat is becoming one of the challenges for producers (Abdelrahman et al., 2012; 2016; Dhen et al., 2018; Rostami et al., 2014).

Both palm dates and coconut belong to the Arecaceae family. So, its fiber is highly similar to the fiber of the coconut fruit. It is rich in lignin, making it hard against microbial decomposition to guarantee its long life span as a growing medium and considerable stability (Basirat, 2011; Dhen et al., 2018). More than 50% of date palms in the world are located in Iran, Iraq, and Saudi Arabia (21% in Iran). The total weight of date palm waste annually produced in the world is estimated at 4.5 million tons (Barreveld, 1993; Zaid & Arias-Jimenez, 2002). Each palm date tree has 37.5-70 kg leaf wastes by year (Khademi et al., 2007). Several reports are showing the potential of the palm peat substrate for growing pot plants. The aforementioned implies that the substrate can replace peat moss for other substrates such as coco peat and perlite (Hematian Dehkordi et al., 2010; Hesami et al., 2010). Palm wastes have a higher water holding capacity than coco peat and can absorb water 8.5 times its dry weight (Chandrasekaran & Bahkali, 2013; Dhen et al., 2018; Shirani, 2013). Wastes of date palm trees seem to be an innovative material in the horticulture industry to be used as growing media (Mohammadi Ghehsareh, 2013) or as an organic fertilizer when used as biochar (Mahdi et al., 2015). The performance of palm-date wastes for plant growth may be leveraged in potted plant production. Still, only a few studies have used palm-date wastes as a substitute for peat and coco peat in potting substrates. Palm celluloid wastes had a significant impact on the growth and total dry weight of *Aglaonema* sp. plants grown in mixing media compared to peat and peat-perlite potting media (Basirat, 2011). According to the results of Samiei et al. (2005) on *Aglaonema commutatum* cv. Silver Queen, a pure coco peat bed, made the highest growth level. There was no significant difference in leave surface index, root, and shoot dry weight between pure peat bed and palm cellulose waste. In growing *Dieffenbachia amoena*, palm waste compost was a suitable substrate for growth and could replace peat up to 70% in the peat-perlite composition (Noorani et al., 2013). Shabani et al. (2011) successfully used palm fibers as a complete or partial substitute for peat substrate in the bell peppers soilless cultivation. The results obtained from several studies revealed that palm waste-derived substrates were suitable for their use in peat substitution (Ceglie et al., 2015; Dhen et al., 2018; Flynn et al., 1995; Mohammadi Ghehsareh, 2013; Rahbarian & Salehi Sardoei, 2014; Rostami et al., 2014).

Information regarding the impacts of composted palm waste on the growth performance of lily is scarce. Thus, keeping in view the above facts, and considering the importance of recycling palm waste residue and the need to find a suitable replacement for coco peat, this study was conducted to evaluate the effects of coco peat replacement by the palm substrate on growth parameters and nutrient uptake in two lily cultivars.

MATERIALS AND METHODS

Plant materials and growth conditions

An experiment was conducted in a greenhouse with a day/night temperature of 20/15 ºC and relative humidity 50-70% at Dehaghan, Isfahan, Iran. Premature bulbs of Oriental Hybrid *Lilium* 'Tiber' and Oriental × Trumpet hybrid *Lilium* 'Candy Club' by approximate 20-22 cm in circumference purchased from Vandenbos Company. Eight bulbs were cultivated into the plastic box (21×37×56 cm) in 12 cm depth, and each box was considered an experimental repeat. Two types of palm substrate (palm trunk: use of only the trunk to prepare; palm tree: use the whole parts of the tree to prepare) were used in this experiment. Moreover, some mixtures of growing media were evaluated for recovery and optimal use of reused coco peat. Finally, eleven combinations of growing media (Table 1) were assessed. All prepared combinations were washed and disinfected by steam before planting. The physical and chemical characteristics of used materials in growing media are shown in Tables 2 and 3.

Four weeks after the containers were placed in the nursery, plants were irrigated using three rows of drip tape placed up against each crate's length, three times a week. Fertilization conducted by the irrigation system at each watering, supplying; (mg l^{-1}) 180 KNO_3, 5.00 NH_4NO_3, 35.0 KH_2PO_4, 275 K_2SO_4, 160 Ca $(NO_3)_2$, 45 $MgSO_4$, 5.00 Fe-EDTA, 1.00 Mn-EDTA, 0.54 Zn-EDTA, 0.05 B_3BO_3, 0.66 $CuSO_4$, and 0.56 Na_2MoO_4. Nutrient Solution pH and electrical conductivity (EC) were 5.5 and 2.8 dS m^{-1}, respectively.

Sampling and trait analysis

Plant height at the flowering time was determined from the bed surface to the plant tip. Also, from the lowest peduncle to the highest bud tip was evaluated as the length of the reproductive organ. All of the open buds on the plants were counted and considered as a buds number. All of the healthy leaves at the flowering time were measured and recorded as the leaves number. The leave's surface area was determined by Image J software and was registered as a leaf surface area (Ahmad et al., 2015; Riazul Islam, 2008). The weight of all bulbs was measured two times, once before planting and then two weeks after flowering. Finally, the bulb depletion rate was determined using the equation (1) (Treder, 2008).

$$\text{Bulb depletion rate} = \frac{(W_0 - W_1)}{W_0} \times 100 \quad (1)$$

W_0: weight before planting
W_1: weight at two weeks after flowering

Table 1. The compositions of used growing media

	Compositions of growing media	Abbreviation
1	80% Coco peat + 20% Perlite	c80+p20 (control)
2	60% Coco peat + 20% Perlite + 20% Palm trunk	c60+p20+ppa20
3	40% Coco peat + 20% Perlite + 40% Palm trunk	c40+p20+ppa40
4	20% Coco peat + 20% Perlite + 60% Palm trunk	c20+p20+ppa60
5	20% Perlite + 80% Palm trunk	p20+ppa80
6	60% Coco peat + 20% Perlite + 20% Palm tree	c60+p20+ppb20
7	40% Coco peat + 20% Perlite + 40% Palm tree	c40+p20+ppb40
8	20% Coco peat + 20% Perlite + 60% Palm tree	c20+p20+ppb60
9	20% Perlite + 80% Palm tree	p20+ppb80
10	20% Fresh Coco peat +20% Perlite + 60% Reused Coco peat	cn20+p20+co60
11	20% Perlite + 80% Reused Coco peat	p20+co80

Table 2. Physical properties of used substrates in growing media

Substrate	Moisture	Porosity	Particle density	Bulk density	Water holding capacity
	%	%	g cm^{-3}	g cm^{-3}	%
Perlite	16.1	73.5	0.45	0.12	91
Coco peat	14.0	73.1	0.52	0.14	812
Reused Coco peat	14.73	73.88	0.61	0.158	692
Palm trunk	13.5	82.3	0.48	0.08	817
Palm tree	19.2	66.9	0.58	0.19	211

Table 3. Chemical properties of used substrates in growing media

Substrate	pH	EC	CEC	N	P	K	Ca	Mn	Mg	Fe	Cu
							Available				
		dS m^{-1}	Cmol kg^{-1}	%			mg kg^{-1}				
Perlite	8.2	0.14	165	0.02	419	100	425	7.0	87	121	1.5
Coco peat	7.0	0.44	227	3.60	420	405	1550	11.0	525	341	2.0
Reused Coco peat	6.7	0.62	220	4.30	618	198	2129	21.5	650	440	0.5
Palm trunk	7.5	0.93	196	3.81	566	38	2275	18.5	712	491	3.0
Palm tree	7.0	0.63	174	4.56	455	47	1775	11.0	500	325	3.0

Physicochemical properties of the substrates and nutrient analysis

The physical properties of the various substrates were determined following the procedures described by Gabriels et al. (1991; 1993). Samples from each of the substrates were wetted thoroughly in bulk batches. Samples of the media were placed into containers of known volumes and weight, with a fine mesh cloth attached to the base. After initial drainage, the substrate level in the container was adjusted. So it was level with the top of the container, saturated with water for 48 h, then allowed to re-drain. The containers were weighed twice, before and after drying in an oven for four days at 60 °C. The ash contents and organic matter contents of the substrate were determined in samples incinerated at 550 °C for five h. From these measurements, the bulk density, particle density, total porosity, and water holding capacity were calculated using the following equations (2, 3, 4, 5 and 6) (Atiyeh et al., 2001; Raviv & Lieth, 2008).

$$\text{Bulk density (g/cm}^3) = \frac{\text{Dry weight}}{\text{Volume}} \quad (2)$$

$$\text{Particle density (g/cm3)} = 1 / [\%\ \text{organic matter} / (100 \times 1.55) + \%\ \text{ash} / (100 \times 2.65) \quad (3)$$

(1.55 and 2.65 are the average particle densities of soil organic and mineral matter, respectively.)

$$\text{Total porosity (\% volume)} = 1 - \frac{\text{Bulk density}}{\text{Particle density}} \times 100 \quad (4)$$

$$\text{Water holding capacity (\% volume)} = \frac{\text{Wet weight} - \text{Dry weight}}{\text{Specific gravity of water} \times \text{Volume}} \times 100 \quad (5)$$

$$\text{Moisture (\%)} = \frac{\text{Wet weight} - \text{Dry weight}}{\text{Dry weight}} \times 100 \quad (6)$$

The pH (1:5 w v^{-1} substrate/double distilled water) was determined by a pH meter (Metrohm-262, Herisau, Switzerland) agitated mechanically for two h and filtered through Whatman no. 1 filter paper. The same solution was measured for electrical conductivity with a flame photometer (Jenway models PFP 7 and PFP 7/C, Staffordshire, United Kingdom) standardized with 0.01 and 0.1 M KCl (Gabriels et al., 1991). Cation-exchange capacity (CEC) was assayed by barium acetate (Rippy & Nelson, 2007). Ten leaf samples treatment, consisting of young, fully expanded leaves were collected, washed thoroughly with tap water, gave a final rinsing with deionized water, dried at 65 ˚C to constant weight and ground to determine their mineral concentration. Total N of growing media and plant samples were measured by the Kjeldahl method described by Goos (1995) and Singh and Pradhan (1981), respectively. The extraction of P, K, Ca, Mg, Fe, Cu, and Mn from the plant tissue material was performed ammonium bicarbonate extraction after dry ashing at 550 ˚C for five h (Soltanpour, 1985). The P concentration was assayed by a spectrophotometer at 880nm (UV-160A UV-Visible Recording Spectrophotometer, Shimadzu, Tokyo, Japan). The K content was measured by a flame photometer (Jenway models PFP 7 & PFP 7/C, Staffordshire, United Kingdom). The Ca, Mg, Fe, Cu, and Mn contents were determined by atomic absorption (670 Shimadzu, Kyoto, Japan) (Black et al., 1965).

Statistical analysis of data

Data analysis was carried out by SAS 9.1 software, and Tukey's range test at the 5% probability level was used to compare the means.

RESULTS AND DISCUSSION

Growth parameters

The results showed that the cultivar and growing media (Except for the number of buds) significantly affected all lily growth characteristics (Table 4). The interactive effect of cultivar and growing media significantly impacted the reproductive organ length and the number of buds (Fig. 1 and 2).

Plant height

The plant height of the Tiber cultivar (108 cm) was more than the Candy Club cultivar (99.8 cm) by an average of 7.9% (Table 4). The most elongate stem (108 cm) was achieved from c40+p20+ppa40, which showed an increase by an average of 1.0% compared to the control (Table 4). However, there was no significant difference with the control. The shortest stem (98.6 cm) was obtained from p20+ppb80 treatment reduced by 7.6% compared to the control (Table 4). The interactive effects of cultivar and growing media had no significant impact on plant height. It is observed that the stem length of lily is affected by the type of growing media, and this effect is related to better water holding capacity as well as better penetration of the roots in the soil (Hassanpour Asil, 2008). Seran et al. (2011) revealed that stem cell growth was reversely correlated with the C/N ratio of growing media. It was also observed that the concentration of N and P of growing media positively related to the length of the stem (Silva et al., 2010). Based on results, the higher N concentration of growing media is not the only influential factor in the length of the stem. The longest stem was produced in control and palm trunk substrates, which had a higher CEC, porosity, and P content as well as a lower concentration of N than the palm tree (Tables 2 and 3). Based on the results, the longest stems are produced in control and palm trunk containing treatments, which had a higher CEC, porosity, and P content and lower the content of N than the palm tree (Tables 2 and 3).

Length of the reproductive organ

The Tiber cultivar (29.4 cm) had a higher length of the reproductive organ than the Candy Club cultivar (28.7 cm) by an average of 2.5% (Table 4). The most increased height of the reproductive organ (31.3 cm) was observed in plants cultivated in c60+p20+ppa20 treatment, which increased by an average of 1.2% compared to the control. However, it was not significantly different from control (Table 4). The shortest length of the reproductive organ (21.1 cm) was obtained from c20+p20+ppb60 treatment reduced by 15.5% compared to the control (Table 4). In the Tiber cultivar, c60+p20+ppa20 treatment increased the length of the reproductive organ by an average of 8.38% compared to the control as the maximum lengths (31.3 cm), while in Candy Club cultivar, the most length (32.9 cm) associated with the control (Fig. 1). The length of the reproductive organ was positively related to the concentration of Ca (Mohammadi Torkashvand & Seyedi, 2016). Table 3 also indicates that the Ca concentration of palm trunk (227 mg kg^{-1}) is more than other growing media ingredients. Observation of the most extended reproductive organ may be due to its highest concentration of Ca.

Number of buds

The Candy Club cultivar (4.56) had a higher number of buds than the Tiber cultivar (4.00) by an average of 14.0%. The growing media had no significant impact on the number of buds (Table 4). The highest number of buds in the Tiber and Candy club cultivar (4.29 and 5.00, respectively) was observed in c60+p20+ppa20 and c60+p20+ppb20, which showed an increase by an average of 6.2% and 10.1%, respectively compared to the control (Fig. 2). Date palm waste properties seem to be enhancer factors for their use as a growing medium, especially when blended with other substrates (Dhen et al., 2018). The plants require suitable physical and chemical conditions such as porosity, storage capacity, ventilation, CEC, pH, EC, etc. For more production of buds and sufficient growth (Mohammadi Ghehsareh et al., 2011). Studies also revealed that the bud number of lily is not affected by growing media (Grassotti et al., 2003; Hassanpour Asil, 2008). Karimi and Hassanpour Asil (2009) also did not observe any effect of growing media on a budding number of lily. Still, various cultivars had a different number of buds, which is consistent with our results.

Number of leaves

The leaves number of the Candy Club cultivar (56.6) was more than the Tiber (54.4) by an average of 3.9% (Table 4). The highest number of leaves (60.1) was achieved in the p20+co80 treatment, which showed an increase by an average of 2.7% compared to the control. However, there was no significant difference between p20+ppa80 and control treatments. On the other hand, the lowest (45.4) was observed in p20+ppb80 treatment reduced by 28.3% compared to the control (Table 4). Dhen et al. (2018) and Rahbarian and Salehi Sardoei (2014) reported that palm-date treatment offers the highest number of leaves that had no significant difference in peat media used as a control that is in line with our study. Environmental conditions like the availability of nutritional elements in growing media could severely affect the number of leaves. The higher number of leaves indicating the good vigor and stability of plants to environmental conditions and growing media. Since N availability of growing media significantly affected the number of leaves in cypress, rye, and common zinnia, the observation of such an increase in the number of leaves may have resulted from N better availability of those treatments (Riaz et al., 2015). These results are in good accordance with our study in the case of palm trunk and control treatments.

Table 4. Effects of cultivar and growing media on the growth characteristics of lily

S.O.V.		Plant height (cm)	Length of the reproductive organ (cm)	Number of buds	Number of leaves	Leaf surface area (cm^2)	Bulb depletion rate (%)
Cultivar	Tiber	108^{a}	29.4^{a}	4.00^{b}	54.4^{b}	21.4^{b}	22.6^{b}
	Candy Club	99.8^{b}	28.7^{b}	4.56^{a}	56.6^{a}	31.8^{a}	36.6^{a}
Growing media	c80+p20 (Control)	107^{ab}	30.9^{a}	4.29^{a}	58.2^{ab}	31.3^{a}	34.0^{a}
	c60+p20+ppa20	107^{ab}	31.3^{a}	4.50^{a}	56.4^{ab}	28.0^{ab}	32.0^{ab}
	c40+p20+ppa40	108^{a}	30.7^{ab}	4.38^{a}	58.6^{ab}	26.6^{ab}	33.5^{a}
	c20+p20+ppa60	106^{a-c}	30.1^{ab}	4.23^{a}	57.2^{ab}	26.3^{ab}	27.2^{ab}
	p20+ppa80	107^{ab}	30.1^{ab}	4.13^{a}	59.8^{a}	28.4^{ab}	30.1^{ab}
	c60+p20+ppb20	103^{a-c}	28.0^{bc}	4.21^{a}	57.4^{ab}	25.6^{ab}	25.5^{ab}
	c40+p20+ppb40	103^{a-c}	29.0^{ab}	4.40^{a}	52.5^{bc}	22.8^{b}	30.2^{ab}
	c20+p20+ppb60	99.8^{bc}	21.1^{c}	4.15^{a}	49.1^{cd}	23.3^{b}	32.6^{a}
	p20+ppb80	98.7^{c}	26.2^{c}	4.33^{a}	45.4^{d}	$23. 6^{b}$	33.9^{a}
	cn20+P20+co60	102^{a-c}	28.0^{bc}	4.23^{a}	56.4^{ab}	28.1^{ab}	25.5^{ab}
	p20+co80	104^{a-c}	29.6^{ab}	4.23^{a}	60.1^{a}	28.7^{ab}	21.1^{b}
Cultivar		**	*	**	*	**	**
Growing media		**	**	ns	**	**	**
Cultivar× Growing media		ns	**	**	ns	ns	ns

Means with the same letter are not significantly different at the 5% probability level according to Tukey's range test. Ns, * and ** represent not significant, significant at 5 and 1 % probability levels, respectively.

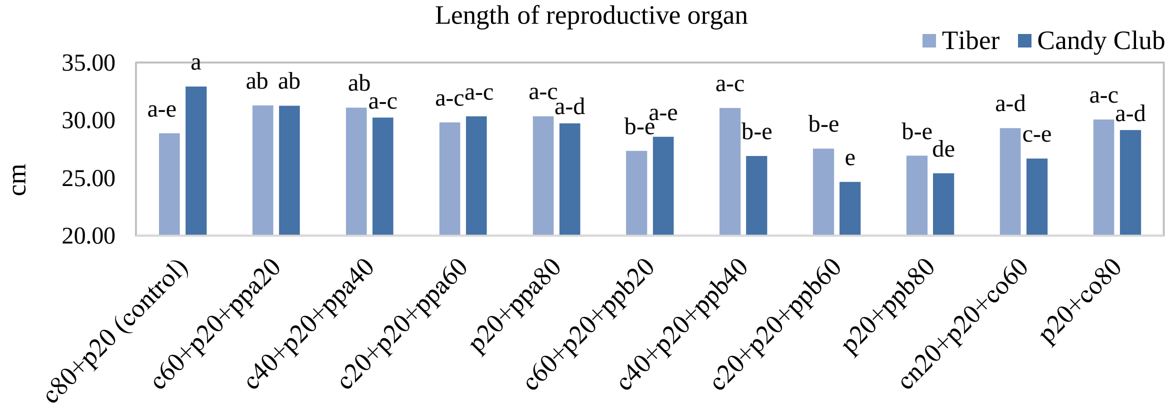

Fig. 1. Effects of cultivar and growing media on the length of the reproductive organ. Columns with the same letter are not significantly different at the 5% probability level according to Tukey's range test.

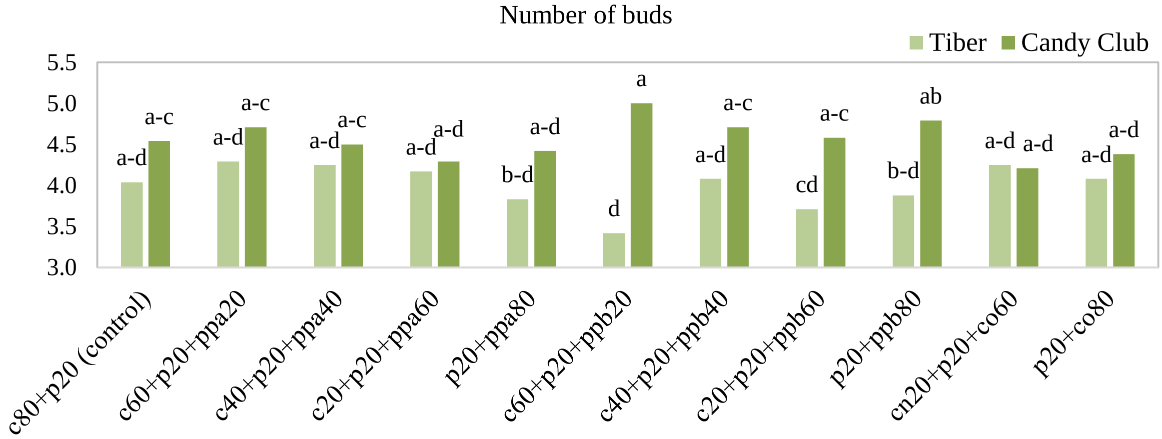

Fig. 2. Effects of cultivar and growing media on the number of buds. Columns with the same letter are not significantly different at the 5% probability level according to Tukey's range test.

Leaf surface area

According to Table 4, the Candy Club cultivar (31.8 cm^2) had a higher leaf surface area than the Tiber cultivar (21.4 cm^2) by an average of 49.0%. The highest leaf surface area (31.3 cm^2) was observed in control, while the lowest values were related to the c40+p20+ppb40 treatment (22.8 cm^2), which decreased by an average of 27.2% compared to the control (Table 4). There are several studies which indicate that the leaf surface area of *Hibiscus rosa-sinensis* (Seran et al., 2011), *Zinnia elegans* (Riaz et al., 2008), *Celosia critata* (Awang et al., 2009), and *Gerbera jamesonii* (Riaz et al., 2015) affected by ingredients of growing media. Leaf area had no significant difference between palm peat and coco peat treatments in Aglaonema (Samiei et al., 2005). Application of the 50% palm peat +25% sand+25% perlite resulted in the highest leaf area in Pandanus plants (Rahbarian & Salehi Sardoei, 2014). In lettuce, media amended with 25 and 50% date palm wastes showed great leaf area values than the 100% peat (Dhen et al., 2018). These findings can be justified, nearly by the substrate's more good aeration enhancing the root oxygen demand and eventually permits more water and nutrients (Borji et al., 2010). Sufficient properties with a view to low bulk density and high porosity in palm peat media lead to better water and nutrient support for the plant and better growth (Dhen et al., 2018). According to these results and by considering only this criterion, coco peat could be replaced by 20-80% palm trunk, 20% palm tree, and 60-80% reused coco peat.

Bulb depletion rate

The bulb depletion rate of the Tiber (22.6%) was less than the Candy Club cultivar (36.6%) by an average of 61.5% (Table 4). The lowest rate (21.1%) was determined in p20+co80 treatment, which decreased with an average of 38.1% compared to the control. However, the highest percentage (34.0) was related to the control (Table 4). There were no significant differences in the bulb depletion rate between control and all of the treatments containing palm trunk and palm tree. Hydrolysis of storage compounds (mainly starch) in mother bulb scales causes a decrease in bulb weight during the initial few weeks after planting. This process happens to support stem growth until the new leaves developed and ensure plant growth. Adverse growth conditions, like insufficient light intensity during forcing and the low fertilizer level, could also increase mother bulb depletion rate and suppress new daughter scales (Treder, 2008). Treder (2008) observed that the application of 1g dm^{-3} of commercial fertilizer (13.26 N, 2.8 P, 15 K, and 2.7 Mg) on coco peat-based growing media could reduce the bulb depletion rate of Star Gazer lily. The results indicated that the most bulb depletion rate occurred in control. All treatments containing palm trunks contained more nutritional elements (except for N) than the palm tree. So it could be concluded that the N concentration of growing media is more effective than the concentration of other nutritional elements on bulb depletion rate and, or ratio of nutritional elements maybe the other factor, which affects the bulb depletion rate. An excellent growing medium would provide sufficient anchorage for the plant, serves as a reservoir for nutrients and water, allow oxygen diffusion to the roots, and permit gaseous exchange between the roots and atmosphere outside the root substrate (Bunt, 1988). The importance of the media's physical properties as the factor in determining plant development in soilless media was in line with the results published earlier (Awang et al., 2009).

Macronutrient

The macronutrient contents of the lily significantly affected by cultivar, growing media, and their interaction (Except for the Mg) that shown in Table 5.

N content

The Candy Club cultivar (3.85%) had a higher N content than the Tiber cultivar (3.67%) by an average of 4.9% (Table 5). The maximum N concentration (3.94%) was observed in plants cultivated in c20+p20+ppa60 treatment, which showed an increase by an average of 4.2% compared to the control. On the other hand, the minimum N concentration (3.55%) determined in the p20+co80 treatment, reduced by 6.1% compared to the control (Table 5). In the Tiber cultivar, c20+p20+ppa60 treatment increased the N content by an average of 16.9% compared to the control as the highest value (3.97%), while in the Candy Club cultivar, the maximum content (3.99 %) related to control (Table 6). In greenhouse tomato, results showed that the media had no significant effect on the concentration of nutrient elements in fruit such as N, P, and K in coco peat, palm peat, and perlite treatments (Borji et al., 2010; Mohammadi Ghehsareh et al., 2011). Al-Ajlouni et al. (2017) observed that there was no linear relationship between the availability of mineral elements of growing media with the concentration of mineral elements on aerial parts of the plant. Still, the higher mineral elements of growing media resulted in higher mineral content in the aerial parts of lily plants. Observation of more N concentration on all palm trunks containing media of the Tiber cultivar could be related to the higher N concentration of palm trunk than other substrates. Hajizadeh et al. (2016) stated that more aerial part's growth than roots could lead to a lesser amount of N in the aerial parts of plants. Therefore, the balanced development of root and shoot may explain the observed results in this study.

P content

The P content of the Candy Club cultivar (105 mg kg^{-1}) was more than the Tiber cultivar (68.6 mg kg^{-1}) by an average of 34.4%. The control registered the highest P concentration (113 mg kg^{-1}). In comparison, the minimum concentration (58.5 mg kg^{-1}) was observed in the p20+ppb80 treatment, which decreased by an average of 93.8% compared to the control (Table 5). The highest P content in Candy Club cultivar (155 mg kg^{-1}) was obtained from control. In comparison, p20+co80 treatment in the Tiber cultivar (79.0 mg kg^{-1}) was recorded the highest P content, which increased by an average of 9.2% compared to the control (Table 6). The acidity of nutrient solution could affect the P absorption (Gruda et al., 2013). So, the presence of a high amount of P in growing media would not lead to the P higher absorption by the plant. The plant roots could also play a leading role in the rhizosphere's acidity by releasing hydrogen and hydroxyl ions against the adsorption of cations and anions. N plays the most critical role in this ionic balance because it could be absorbed as an anion like nitrate or a cation like ammonium. However, plants' changes in acidity also depend on soil buffering capacity (Mikkelsen, 2013). Therefore, observation of the lowest P concentration of both cultivars in 80% palm tree treatment may be due to the low P content of this substrate (Table 3). The observed differences between P concentrations of cultivars possibly related to root secreted substances, which led to the change of acidity of growing media.

K content

The Candy Club cultivar (142 mg kg^{-1}) had a higher K content than the Tiber cultivar (126 mg kg^{-1}) by an average of 11.2%. The highest K content (154 mg kg^{-1}) was achieved in the c60+p20+ppb20 treatment, which showed an increase by an average of 3.5% compared to the control. On the other hand, the lowest value (109 mg kg^{-1}) was observed in c20+p20+ppa60 treatment reduced by 25.6% by comparison to the control (Table 5). According to Table 6, in the Tiber and Candy Club cultivar, c60+p20+ppb20 treatment increased the K content by an average of 8.1% and 15.8%, respectively, compared to the control the highest value (143 and 165 mg kg^{-1}, respectively). In *Celosia cristata*, different media combinations (coco peat, burnt rice hull, perlite, and kenaf core fiber) did not significantly affect N, P, K, Ca, and Mg contents (Awang et al., 2009). K availability is dependent on plant species, plant growth stage, water flux rate, and root factors (Baligar, 1985). K moves to the new roots mainly by diffusion and water flow (Baligar, 1985). The K concentration of the palm tree was more than the palm trunk, but it was not more than the coco peat (Table 3). Therefore, the excellence of palm tree than palm trunk treatments possibly due to its higher K concentration. The superiority of the palm tree than control also may be due to its lower water holding capacity, which causes an increase in the water flux rate and consequently conduct the K to the roots. The reduction of K concentration of growing media by the rise in palm peats and reused coco peat probably result in the observation of the decreasing manner in K absorption of plants. The observed difference between the K absorption of cultivars also perhaps resulted from the different growth rates of roots.

Table 5. Effects of cultivar and growing media on the nutrient content of lily leaves

S.O.V.		N	P	K	Ca	Mg	Fe	Cu	Mn
		%				mg kg^{-1}			
Cultivar	Tiber	3.67^{b}	68.6^{b}	126^{b}	80.4^{a}	15.5^{b}	0.63^{a}	0.47^{a}	0.06^{a}
	Candy Club	3.85^{a}	105^{a}	142^{a}	77.3^{b}	19.1^{a}	0.55^{a}	0.47^{a}	0.05^{a}
Growing media	c80+p20 (Control)	3.78^{a-c}	113^{a}	137^{b}	61.6^{e}	21.4^{a}	0.51^{ab}	0.38^{c}	0.07^{b-d}
	c60+p20+ppa20	3.84^{ab}	96.4^{b}	132^{bc}	77.3^{cd}	20.5^{ab}	0.53^{ab}	0.42^{c}	0.04^{de}
	c40+p20+ppa40	3.75^{a-c}	89.1^{bc}	116^{d}	95.1^{ab}	16.2^{d-f}	0.83^{a}	0.45^{c}	0.03^{e}
	c20+p20+ppa60	3.94^{a}	98.6^{bc}	109^{d}	84.1^{bc}	13.2^{g}	0.48^{b}	0.46^{c}	0.02^{e}
	p20+ppa80	3.86^{ab}	8.00^{bc}	122^{cd}	103.9^{a}	15.1^{fg}	0.49^{b}	0.50^{bc}	0.02^{e}
	c60+p20+ppb20	3.72^{a-c}	86.7^{bc}	154^{a}	69.6^{de}	20.1^{a-c}	0.79^{ab}	0.64^{ab}	0.11^{a}
	c40+p20+ppb40	3.68^{bc}	79.4^{cd}	145^{ab}	72.5^{c-e}	18.5^{b-d}	0.52^{ab}	0.40^{c}	0.05^{c-e}
	c20+p20+ppb60	3.91^{ab}	67.7^{de}	144^{ab}	75.2^{cd}	15.8^{e-g}	0.56^{ab}	0.46^{c}	0.06^{b-e}
	p20+ppb80	3.76^{a-c}	58.5^{e}	133^{bc}	70.9^{de}	14.9^{fg}	0.49^{ab}	0.68^{a}	0.05^{c-e}
	cn20+P20+co60	3.58^{c}	87.0^{bc}	144^{ab}	76.2^{cd}	17.7^{c-e}	0.66^{ab}	0.42^{c}	0.08^{a-c}
	p20+co80	3.55^{c}	98.7^{b}	139^{b}	80.7^{cd}	16.6^{d-f}	0.61^{ab}	0.34^{c}	0.09^{ab}
Cultivar		**	**	**	*	**	ns	ns	ns
Growing media		**	**	**	**	**	**	**	**
Cultivar×Growing media		**	**	**	**	ns	ns	**	*

Means with the same letter are not significantly different at the 5% probability level according to Tukey's range test. Ns, * and ** represent not significant, significant at 5 and 1 % probability levels, respectively.

Ca content

The Ca concentration of the Tiber cultivar (80.4 mg kg^{-1}) was more than the Candy Club cultivar (77.3 mg kg^{-1}) by an average of 3.9%. The p20+ppa80 treatment registered the highest Ca content (104 mg kg^{-1}), which increased by an average of 40.7% compared to the control, while the lowest content (61.6 mg kg^{-1}) was observed in the control (Table 5). The highest Ca content in the Tiber, and Candy Club cultivar (113.95, 93.84 mg kg^{-1}, respectively) was obtained from p20+ppa80 treatment, which increased by an average of 112.9% and 34.6% compared to the control (Table 6). It was observed that the Ca concentration of lower and middle leaves of the lily plants is correlated to the Ca status of bulbs. On the other hand, the Ca concentration of higher leaves and buds is mainly related to absorbed Ca by roots (Al-Ajlouni et al., 2017). Al-Ajlouni et al. (2017) also revealed that the Ca concentration of lily stems are directly related to Ca availability of growing medium. The results indicated that the highest amount of Ca observed in plants cultivated on growing media with the highest amount of Ca, which is in good accordance with those reported by Al-Ajlouni et al. (2017). Observation of the higher absorption of Ca by plant cultivated on palm tree than the control plants maybe resulted from its higher N concentration. In lily plants, it was revealed that a rise in N concentration could lead to an increase of Ca absorption even by a constant amount of Ca in nutritional solution (Marin et al., 2011).

Mg content

The Candy Club cultivar (19.1 mg kg^{-1}) had a higher Mg content than the Tiber cultivar (15.5 mg kg^{-1}) by an average of 23.2% (Table 5). The highest value of Mg content (21.4 mg kg^{-1}) was observed in plants cultivated in control, while the lowest value (13.2 mg kg^{-1}) was achieved from c20+p20+ppb60 treatment reduced by 38.0% compared to the control (Table 5). There was also a declining trend in Mg concentration by increasing both types of palm peat (Table 5). Since absorption of Mg is related to CEC and the availability of other cations of growing media (Yan & Hou, 2018), the observation of such results may be related to the higher coco peat CEC and also the amount of other cationic nutritional elements.

Micronutrient

According to Table 5, the growing media and interactive impact of cultivar and growing media (Except for the Fe) significantly affected all micronutrient contents of the lily plants (Table 5).

Fe content

According to Table 5, the maximum Fe content (0.83 mg kg^{-1}) was observed in plants cultivated in the c40+p20+ppa40 treatment, which showed an increase by an average of 38.3% compared to the control. On the other hand, the minimum Fe content (0.48 mg kg^{-1}) determined in c20+p20+ppa60 treatment, reduced by 5.9% compared to the control (Table 5). Fe is the most abundant element of the earth's crust, but its solubility and absorption under aerobic conditions are very low, especially in alkaline and lime soils (Kobayashi & Nishizawa, 2012). Palm trunk had the highest Fe than the other substrates, but it is slightly more alkaline than other substrates. According to Table 3, it seems that coco peat had buffering capacity because the composition of coco peat and perlite (pH=7) had a lower pH than perlite (pH=8.2). So, observation of the higher absorption of Fe in 40 % palm trunk than other palm trunk treatments could be related to synergistic effects of acidity and concentration of Fe. Further studies are needed to determine the reason for the high concentration of Fe in the 20% palm tree treatment than in control.

Table 6. The interactive effects of cultivar and growing media on the nutrient content of lily leaves

S.O.V.		N	P	K	Ca	Mg	Fe	Cu	Mn
		%	mg kg^{-1}						
	c80+p20 (Control)	3.57^{cd}	71.7^{e-g}	132 $^{c-g}$	53.5^{f}	19.6^{a}	0.50^{a}	0.37^{c-e}	0.08^{a-d}
	c60+p20+ppa20	3.80^{a-c}	64.0^{fg}	120^{f-h}	71.3^{ef}	17.6^{a}	0.49^{a}	0.47^{a-e}	0.03^{d-f}
	c40+p20+ppa40	3.89^{a-c}	70.0^{e-g}	112^{gh}	106^{ab}	15.0^{a}	0.83^{a}	0.36^{c-e}	0.03^{d-f}
	c20+p20+ppa60	3.97^{ab}	69.0^{e-g}	97.7^{h}	83.5^{c-e}	10.6^{a}	0.43^{a}	0.41^{c-e}	0.02^{ef}
	p20+ppa80	3.91^{a-c}	68.0^{e-g}	121^{e-h}	114^{a}	13.3^{a}	0.51^{a}	0.55^{a-d}	0.02^{f}
Tiber	c60+p20+ppb20	3.61^{b-d}	70.5^{e-g}	143^{a-e}	71.3^{ef}	19.5^{a}	0.06^{a}	0.61^{a-c}	0.09^{a-e}
	c40+p20+ppb40	3.59^{cd}	72.5^{e-g}	141^{b-f}	66.7^{ef}	17.3^{a}	0.55^{a}	0.43^{b-e}	0.05^{b-f}
	c20+p20+ppb60	3.88^{ac}	70.0^{e-g}	135^{c-g}	79.0^{c-e}	14.1^{a}	0.68^{a}	0.50^{a-e}	0.07^{a-e}
	p20+ppb80	3.61^{bd}	52.7^{g}	135^{c-f}	67.0^{ef}	12.1^{a}	0.51^{a}	0.71^{a}	0.04^{b-f}
	cn20+P20+co60	3.30^{d}	67.5^{e-g}	125^{d-g}	80.6^{c-e}	16.0^{a}	0.65^{a}	0.33^{de}	0.06^{b-f}
	p20+co80	3.31^{d}	79.0^{ef}	126^{d-g}	91.7^{b-d}	15.2^{a}	0.71^{a}	0.42^{b-e}	0.09^{ab}
	c80+p20 (Control)	3.99^{a}	155^{a}	143^{a-f}	69.7^{ef}	23.1^{a}	0.52^{a}	0.40^{c-e}	0.06^{b-f}
	c60+p20+ppa20	3.88^{a-c}	129^{b}	145^{a-d}	83.3^{c-e}	23.4^{a}	0.57^{a}	0.37^{c-e}	0.05^{b-f}
	c40+p20+ppa40	3.61^{bd}	108^{bc}	120^{e-h}	84.5^{c-e}	17.4^{a}	0.82^{a}	0.54^{a-d}	0.03^{d-f}
	c20+p20+ppa60	3.92^{a-c}	106^{cd}	121^{e-h}	84.6^{c-e}	16.9^{a}	0.54^{a}	0.51^{a-e}	0.03^{d-f}
	p20+ppa80	3.81^{a-c}	108^{c}	123^{d-g}	93.8^{bc}	16.9^{a}	0.47^{a}	0.44^{b-e}	0.03^{d-f}
Candy Club	c60+p20+ppb20	3.83^{a-c}	103^{cd}	165^{a}	67.9^{ef}	20.8^{a}	0.526^{a}	0.66^{a}	0.13^{a}
	c40+p20+ppb40	3.77^{a-c}	86.2^{de}	149^{a-c}	78.4^{c-e}	19.7^{a}	0.49^{a}	0.37^{c-e}	0.04^{d-f}
	c20+p20+ppb60	3.94^{a-c}	65.5^{fg}	152^{a-c}	71.3^{ef}	17.4^{a}	0.43^{a}	0.42^{b-e}	0.04^{c-f}
	p20+ppb80	3.92^{a-c}	64.2^{fg}	131^{c-g}	74.8^{de}	17.8^{a}	0.47^{a}	0.66^{ab}	0.05^{b-f}
	cn20+P20+co60	3.86^{a-c}	106^{cd}	162^{ab}	71.7^{ef}	19.5^{a}	0.66^{a}	0.51^{a-d}	0.10^{ab}
	p20+co80	3.79^{a-c}	118^{bc}	152^{a-c}	69.7^{ef}	18.0^{a}	0.51^{a}	0.26^{e}	0.08^{a-d}

Means with the same letter are not significantly different at the 5% probability level according to Tukey's range test. ns, * and ** represent not significant, significant at 5 and 1 % probability levels, respectively.

Cu content

The p20+ppa80 treatment registered the highest Cu content (0.68 mg kg^{-1}) by an average of 44.2% compared to the control. In comparison, the minimum concentration (0.34 mg kg^{-1}) was obtained from p20+co80 treatment, which decreased by an average of 12.0% compared to the control (Table 5). The highest Cu content in the Tiber and Candy Club cultivar (0.71 and 0.663 mg kg^{-1}, respectively) recorded in p20+ppa80 and c60+p20+ppb20 showed an increase by an average of 91.3% and 67.4%, respectively compared to the control (Table 6). Roosta et al. (2015) observed that the Cu concentration of rose plants declined with increasing coco peat, consistent with our results. Among the substrate used in the growing medium, palm peat types had the same amount of copper and had a higher amount of copper than other substrates (Table 3). It has been observed that the increase in the Cu concentration of the soil leads to an increase in the Cu concentration of grape leaves (Miotto et al., 2014). According to the results, it can be concluded that observation of the highest concentration of Cu in the 80% palm tree is caused by its higher content in the palm peat substrate (Table 3). However, the Cu content of plants cultivated on 80% palm trunk is lower than those grown on the 80% palm tree. In addition to the growing media Cu content, other factors like decomposition rate, also affect the uptake and accumulation of Cu in the plant.

Mn content

The plants cultivated in p20+ppa80 treatment registered the highest Mn content (0.11 mg kg^{-1}), which increased by an average of 38.7% compared to the control. In comparison, the minimum concentration (0.02 mg kg^{-1}) was observed in c20+p20+ppb60 and p20+ppb80 treatments reduced by 78.4% compared to the control (Table 5). The highest Mn content in the Tiber and Candy Club cultivar (0.09 and 0.13 mg kg^{-1}, respectively) was obtained from p20+co80 and c60+p20+ppa20 treatment, which increased by an average of 22.1% and 54.3% compared to the control (Table 6). An increase in the coco peat content of rose's growing media led to increased Mn content (Roosta et al., 2015). The results demonstrate that the Mn content negatively correlated to the percentage of both palm peat types (especially the palm trunk). The absorption of Mn is under the effects of soil acidity so that, its absorption is easier in acidic soil than alkaline soils. Also, the concentration of other nutritional elements like Fe, Mg, Ca, and P also affects the absorption of Mn. So, the higher content of those elements prevents the absorption of Mn (Socha & Guerinot, 2014). Palm trunk is slightly alkaline and has a higher concentration of Fe, Mg, Ca, and P (Table 3), which seems to be one of the influential factors on the lowest concentration of Mn in plants cultivated on the palm trunk treatments. The possible reason for the observation of superiority of 20% palm tree than other treatments may be due to the equilibration of the P, Ca, and Fe.

CONCLUSION

The present study reveals that various cultivars showed different responses to the growing media and supply of 20-80% of palm trunk, 20-40% palm tree, and 60-80% reused coco peat improve plant growth parameters for the soilless culture of the cut lily flower. This favorable rate is estimated by profitable plant growth (plant height, length of the reproductive organ, number of leaves, leaf area, bulb depletion rate) compared to 80% coco peat. Among these two palm peats and their effects on plant characters, palm trunk substrates were superior to palm tree substrates. Palm trunk substrates also had an obvious advantage in plant height and number of leaves over the control treatment. In terms of nutrient contents, however, both types of the palm peat were superior in some elements, It cannot be stated in general which was superior to the other, but they were better (K, Ca, Cu and Mn) or similar (N, Mg, and Fe) to the control treatment.

From the obtained results, it can be concluded that palm substrate has a great potential to be used in a mixture as a substrate for plant growth in soilless systems. Physico-chemical properties of palm substrates appeared to be suitable and were within the optimum range. Considering that coco peat as commercial growing media is an imported substrate in many countries, palm waste is a promising project. Switching to an alternative material can be too costly and complicated if it does not possess very similar coco peat properties. So, a mixture of a new organic medium with commercial coco peat may convince transplant producers.

Future studies should be aimed at improving and optimizing the proportion of used palm waste. An investigation on obtaining substrate properties using advanced analysis such as morphology and surface chemistry analysis would be fascinating.

Conflict of interest

The authors declare no conflict of interest.

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