Journal of Ornamental Plants
Available online on: www.jornamental.com
ISSN (Print): 2251-6433 ISSN (Online): 2251-6441

Enhancement of Growth Performances of *Ophiopogon japonicus* Ornamental Foliage Plant

S.M.K.H. Wijayabandara [1*], J.W. Damunupola [2], S.A. Krishnarajah [3], W.A.M. Daundasekera [2] and D.S.A. Wijesundara [3]
[1] Postgraduate Institute of Science, University of Peradeniya, Sri Lanka
[2] Department of Botany, University of Peradeniya, Sri Lanka
[3] Royal Botanic Gardens, Department of National Botanic Gardens, Peradeniya, Sri Lanka

Received: 26 April 2015 Accepted: 24 June 2015
*Corresponding author's email: hansani8526@gmail.com

Abstract

Ophiopogon japonicus is a perennial, ornamental foliage plant, which belongs to the family Liliaceae. It has a high demand in the local and international export market due to the presence of glossy white-green stripped lanceolate leaves. Improved leaves and plants of *O. japonicus* will be more popular in the floriculture industry. Hence, objective was to investigate the growth responses of *O. japonicus* for best potting media and fertilizer treatments. Shoots of *O. japonicus* trimmed up to 4 cm from the root-shoot junction were potted in two potting media as soil type 1, coir dust, compost and sand as 1:1:1 and soil type 2, sand, coir dust 1:1 by volume. High nitrogen fertilizer, balanced fertilizer and high phosphorous fertilizer were applied as foliar sprays in three concentrations (×1/2, ×1 and ×2 times of the RBG recommended dosages) and distilled water was used as the control. There was a significant ($p<0.05$) effect of growing media on the *O. japonicus* leaf length, plant fresh weight, shoot dry weight, root dry weight, number of leaves and number of shoots. However, there was no significant difference between the control and fertilizer treatments on leaf length, shoot dry weight, number of leaves and number of shoots while there was a significant difference among fertilizer treatments on plant fresh weight and root dry weight. Most effective potting media and fertilizer treatment for *O. japonicus* were sand:coir dust media (1:1) and Royal Botanic Gardens, Sri Lanka-recommended dosage (RBG) of fertilizer treatments (high nitrogen (2.5 g/L), balanced (1.25 g/L) and high phosphorous fertilizer (2.5 g/L), respectively.

Keywords: Fertilizer, Floriculture industry, Potting media.

INTRODUCTION

Ophiopogon japonicus is a perennial, ornamental foliage plant, belonging to the family Liliaceae (USDA, 2013). It is an easy crop to grow and leaves can be harvested 5-8 months after planting hence earnings from the crop is quick compared to other crops. It is a very valuable and widely utilized plant species in indigenous Chinese medicine as well (Ye *et al.*, 2005). *O. japonicus* has a high demand in the international foliage export industry due to the presence of attractive white-green stripped lanceolate leaves. However, one of the selection criteria for this foliage species is the demand for long leaves (50-60 cm), which is a limiting factor at the moment. Improved leaves and plants of *O. japonicus* will be more popular in the floriculture industry. The long, bright coloured, shiny, straight, healthy leaves with increased postharvest longevity will increase the prevailing demand.

In ornamental plant production, selecting the most appropriate media is essential (Fitzpatric, 1981). There are different types of potting medium components such as peat, pine bark, animal manure, calcinied clay (Dewayne *et al.*, 1993) coir dust: sand: compost (Herath *et al.*, 2013).

Compost is produced by recycling organic disposal materials with the aid of micro flora under specific temperature and aeration conditions (Badar and Qureshi, 2014). Due to the increment of organic matter content the physical, chemical and biological properties of soil can be enhanced with compost (Liu *et al*., 2013). Kiran *et al*. (2007) recommended leaf mold or house waste compost as the best potting media for development of bulbs of *Dahila* sp. Furthermore, Castro *et al.* (2008) reported urban waste compost as the most suitable media for *Chrysanthemum* production.

Coir dust is a dominant by-product in coconut fiber production. It can be used to improve depleted soil by maintaining its organic matter content (Vidhana Arachchi and Somasiri, 1997). According to Rubasinghe *et al.* (2009), *Chiritamoonii*, which is an endemic wild flowering plant, produced less vigorous roots with less number of adventitious roots in sand media compared to sand: coir dust medium. Moreover, the highest fresh weight of root, highest root length and highest shoot length was observed in sand: coir dust medium.

Fertilizers are supplied as nutrient improvers for soil and enhance the productivity of crops (Ingles, 2004). However, optimum nutrient range varies with the plant species. A complete fertilizer should consist of nitrogen (N), phosphorous (P) and potassium (K), which are essential for plant growth. Nitrogen increases leaf length (Rademacher and Nelson, 2001) while P enhances the rapid growth of plants. Potassiumin volves in many functions in plants such as enzyme activity, protein synthesis, photosynthesis, osmoregulation, stomatal movement, energy transfer, phloem translocation, ionic balance and stress resistance (Wang *et al*., 2013). El-Naggar and El-Nashorty (2009) stated that the number of leaves per plant of *Hippeastrum vittatum* had increased significantly by using complete fertilizer of N:P:K (19:19:19) at 5 g/plant. Kapugama and Peiris (2010) showed that the balance complete fertilizer with 20:20:20 ratio performed well on *Anthurium* sp. cv"Tropical Red". Chemical fertilizers such as anhydrous ammonia, ammonium nitrate, urea, super phosphate, ammoniated phosphates, potassium nitrate and potassium chloride are the most commonly used fertilizers (Ingles, 2004). Hence, in this study the objective was to investigate the growth responses of *O. japonicus* for different potting media and fertilizer treatments.

MATERIALS AND METHODS

Study site

The experiments were conducted in the semi glass house of the Department of Botany, Faculty of Science, University of Peradeniya, Sri Lanka during the period of January to June 2013 (mean average temperature 27 ± 2 ^{o}C, mean average humidity 78 ± 2%).

Plant material

Healthy plants of *O. japonicus* were obtained from the Royal Botanic Gardens (RBG), Peradeniya (7° 15' 47" N, 80° 36' 10"E) and Kandyan home gardens (7° 17' 47" N, 80° 38' 6" E).

Establishment of plant material in different potting media

Plastic pots of 14 cm in diameter and 13 cm in depth were used for the trial, filled with two types of media. Soil type 1 contained a mixture of coirdust, compost and sand 1:1:1 by volume. Soil type 2 contains a mixture of sand and coir dust 1:1 by volume. Shoots of *O. japonicus* trimmed up to 4 cm from the shoot- root junction were potted.

Fertilizer application

Three different fertilizer treatments; high nitrogen fertilizer (30:10:10), balanced fertilizer (20:20:20) and high phosphorous fertilizer (10:52:10) were applied in three concentrations (×1/2, ×1 and ×2 times of the RBG recommended dosages; i.e. recommendations made by the Royal Botanic Gardens, Sri Lanka) as foliar sprays. Distilled water was used as the control. Fertilizer treatments were given four weeks after plant establishments. High nitrogen fertilizer and balanced fertilizer were spayed at ten days intervals, for a period of two and half months. Consequently, high phosphorus and balanced fertilizer treatments were carried out same as above for the same duration. Two types of potting media and four fertilizer treatments as a factorial design were established. Each treatment consisted of 15 replicates. Pots were arranged randomly in a completely randomized design. Three trials were carried out separately.

Growth parameters measured

Six months after the plant establishment, length of leaves, number of new shoots and number of new leaves were measured. Roots and shoots were oven dried separately at 70ºC for 48 hours and dry weight of shoots and dry weight of roots were taken (Hettiarachchi *et al.*, 2010).

Data were analyzed using the two-way ANOVA procedure in the SAS statistical software (version 9.13). Duncan mean separation test was used to identify the significant differences among the treatments.

RESULTS

Most suitable potting media and fertilizer application

Leaf length

Results showed that different potting media had a significant effect ($p<0.05$) on *O. japonicus* leaf length while there was no significant difference between the control and fertilizer treatments on leaf length. The highest leaf length (12.4 cm) was recorded in S_2F_1 (coir: sand media with RBG recommended dosage of fertilizer) treated plants while lowest leaf length (3.5 cm) was recorded in S_1F_2 (compost: coir: sand media with twice of RBG recommended dosage of fertilizer) treated plants. When comparing highest leaf lengths of plants grown in both soil types, leaf length of plants grown in S_2 media showed a 3.5 fold increment than plants grown in S_1 media. Furthermore, according to the results, in both potting media, the lowest leaf length was reordered in F_2 (twice of RBG recommended dosage of fertilizer) treated plants. This may be due to over dose of fertilizer treatments causing retardation of the increment of leaf length (Table 1).

Number of new shoots

There was a significant difference ($p<0.05$) on the number of shoots of *O. japonicus* when grown on sand:coir dust mixed potting media than compost:sand:coir dust media. Number of shoots were higher in plants grown in S_2 comparerd to S_1. The highest number of new shoots (1.47) was observed in S_2F_1 treated plantscomparerd to other treatments.The lowest number of new shoots (0.47) was recordered in $S_1F_{1/2}$treated plants. However, there was no significant difference between fertilizer treatments on number of shoots (Table 1).

Number of new leaves

There was no significant difference in the number of new leaves with different concentra-

Table 1. Average leaf length, fresh weight of plant, number of new leaves, number of new shoots, dry weight of shoots and roots of *O. japonicus* with respect to different potting media and fertilizer treatments.

Medium	Treatment	Leaf length (cm)	Plant fresh weight (g)	Number of new leaves	Number of new shoots	Shoot dry weight (g)	Root dry weight (g)
S_1	F_0	6.7^{a}	2.031^{a}	4.27^{a}	0.60^{a}	0.137^{a}	0.106^{ab}
S_1	$F_{1/2}$	4.0^{a}	1.945^{a}	3.27^{a}	0.47^{a}	0.098^{a}	0.074^{b}
S_1	F_1	5.8^{a}	2.550_{b}	4.47^{a}	0.73^{a}	0.101^{a}	0.091^{a}
S_1	F_2	3.5^{a}	1.128^{a}	2.67^{a}	0.53^{a}	0.039^{a}	0.053^{b}
S_2	F_0	10.9^{b}	3.688_{c}	6.33^{b}	1.13^{b}	0.191^{b}	0.235^{cd}
S_2	$F_{1/2}$	9.4^{b}	3.564_{c}	7.07^{b}	1.07^{b}	0.195^{b}	0.201^{d}
S_2	F_1	12.4^{b}	7.267^{d}	8.93^{b}	1.47^{b}	0.313^{b}	0.418^{c}
S_2	F_2	7.9^{b}	2.958_{c}	5.47^{b}	0.8^{b}	0.175^{b}	0.16^{d}
LSD(n=15)		3.37	1.84	NS	NS	0.10	0.09

Control (F0), ½ (RBG recommendered fertilizer) (F1/2), RBG recomendered fertilizer (F1), 2 (RBG recomendered fertilizer) (F2) in soil type 1 sand: coir: compost (S1) and soil type 2 sand: coir (S2). Means that do not share a letter are significantly different for a particular medium and or fertilizer treatments.

tions of fertilizer treatments. The highest number of new leaves were obtained in S_2F_1 (8.93) treated plants whereas lowest number of leaves were recorded in S_1F_2 (2.67) treated plants. Number of new leaves were higher in plants grown in S_2 comparerd to S_1 (Table 1).

Fresh weight of plants

There was a significant difference ($p<0.05$) between potting media as well as fertilizer treatments on the fresh weight of plants of *O. japonicus*. Highest fresh weight of plants was recordered in S_2F_1 (7.27 g) treated plants while the lowest fresh weight of plants was recorded in S_1F_2 (1.13 g) treated plants. Thus, fresh weight of plants was higher in plants grown on S_2 comparerd to S_1 (Table 1).

Dry weight of shoots

Regarding the dry weight of shoots, different potting media showed a significant difference ($p<0.05$) while similar trend was observed in different fertilizer treatments. The highest dry weight of shoots (0.31 g) was observed in S_2F_1 treatment while lowest (0.04 g) obtained with S_1F_2 treated plants (Table 1).

Dry weight of roots

Results in table 1, indicates the significant difference ($p<0.05$) of root dry weight due to diferent potting media as well as fertilizer tretments. Highest average root dry weight (0.42 g) was recorded in S_2F_1 treatments while lowest (0.05 g) obtained S_1F_2 treated plants (Table 1).

DISCUSSION

Two types of potting media coir: compost: sand (S_1) and coir: sand (S_2) and three different fertilizer treatments (×1/2, ×1 and×2 times of the RBG recommended dosages) of high N, P and balanced fertilizer were used in this study. Growth of *O. japonicus* was investigated under 6 parameters; length of leaves, number of new shoots, number of new leaves, fresh weight of the plants, dry weight of shoots and dry weight of roots. Results of the present study showed that S_2 media promoted *O. japonicus* plant growth than S_1 media.

Coir dust can retain high amount of water due to its high water holding capacity. Roots tend to absorb water and thus leaf length can be increased. Furthermore, particle density of coir is low and it indicates the presence of high specific surface. These characters of coir are the evidence of high absorption capability of water and ions (Rubasinghe *et al.,* 2009). In general, pore size contributes to the distribution of water and air in the soil and affects growth of a plant (Vidhana Arachchi and Somasiri, 1997). Coir is used as a substitute to peat and is commercially popular worldwide as a potting media for ornamental plants. Further, it is environmentally friendly and low cost (Ahmad *et al*., 2012).

Plants grown in S_1, which contained compost, showed a reduction of leaf length compared to the plants grown in S_2 potting media. This can be due to many reasons such as, release of nutrients in compost at a very slow rate that are not in readily available form to plants. Thus, plants may be unable to absorb essential amount of nutrients (Seran *et al*., 2010). Further, compost medium can vary in content and may consist of heavy metals and pathogens as well. However, some compost media contain inherent deficiencies such as high salinity, leading to stunted growth and chlorosis of plants (Bugbee, 2002), inappropriate pH value and high heavy metal concentration (Wilson *et al.,* 2001). Burger *et al.* (1997) suggested that, composted green waste have to be blended with other growing material such as perlite and peat moss in order to minimize above mentioned deficiencies. In contrast to Burger *et al.* (1997), Wilson *et al.* (2001) recorded that a perennial ornamental plant, *Orthosiphon stamineus* reduced its growth in peat or coir dust amended with compost media, which is also in accordance with our results.

Fain and Paridon (2004) reported that calcinied clay produced higher quality *O. japonicus* plants than standard nursery media. According to their view it reduces labor cost, which is required to harvest bare root production. Herath *et al*. (2013) reported that leaf mould: soil: sand in 1:1:1 was the best soil medium for the growth of *O. japonicus*. High levels of N, P, K can be toxic to plants and retard its growth (De Lucia *et al.,* 2013). According to results obtained, there was no significant effect of different concentrations of fertilizer treatments on leaf length, number of leaves, and number of shoots and dry weight of shoots. Further, findings of Broschat *et al*. (2008) concluded that the visual quality of *Stenotaphrum secundatum* 'Floratam', *Pentas lanceolata, Nandina domestica*, and *Allamanda cathartica* 'Hendersoni' were similar for all fertilizer types tested. Three different fertilizer concentrations (×1/2, ×1 and ×2 times of the RBG recommended dosages) of high N, P and balanced fertilizer were used in this study. Half a dosage of fertilizer was used to compare the yield with the RBG recommended dosage in order to reduce the cost on fertilizer. Meanwhile, twice the RBG dosage was used to check whether it gives a higher yield than RBG recommended dosage. However, there was a significant difference among fertilizer levels on root dry weight and plant fresh weight. Fresh weight and dry weight are factors, which are used to assess plant growth (Taiz and Zeiger, 1991). Maximum growth and best quality yield can be harvested with the accurate combination of nutrients with a suitable potting media (Ahmad *et al.*, 2012).

According to the results, we recommend coir: sand media and RBG recommended dosages of fertilizer for speedy increment of leaf length in *O. japonicus*, which will enhance the marketability this ornamental foliage plant.

.

CONCLUSION

Most effective potting media and fertilizer treatment for *O. japonicus* were sand: coir media with Royal Botanic Gardens, Sri Lanka recommended dosage of fertilizer treatment i.e.,high nitrogen (2.5 g/L), balanced (1.25 g/L) and high phosphorous fertilizers (2.5 g/L), respectively.

ACKNOWLEDGEMENT

Financial assistance by the National Science Foundation, Sri Lanka (NSF Grant No. RG/2012/AG/03) is acknowledged.

Literature Cited

Ahmad, I., Ahmad, T., Gulfam, A. and Saleem, M. 2012. Growth and flowering of gerbera as influenced by various horticultural substrates. Pakistan Journal of Botany,44: 291-299.

Badar, R. and Qureshi, S.A. 2014.Composted rice husk improves the growth and biochemical parameters of sunflower plants. Journal of Botany, Volume 14, Article ID 427648, 6 pages.

http://dx.doi.org/10.1155/2014/427648.
Broschat, T.K., Sandrock, D.R., Elliott, M.L. and Gilman, E.F. 2008. Effects of fertilizer type on quality and nutrient content of established landscape plants in Florida. Hort Technology, 18 (2): 278-285.
Bugbee, G.J.2002. Growth of ornamental plants in container media amended with biosolids compost. Compost Science and Utilization,10: 92-98.
Burger, D.W., Hartz, T.K. and Forister, G.W. 1997. Composted green waste as a container medium amendment for the production of ornamental plants. HortScience, 32(1): 57-60.
Castro, C., Siva, A.M., Da Pauletti, S.C., Spacki, D.R., Vacarin, A.P., Silva, R.N.D., Da Dartora, L.P.E. 2008. Organic residues in the culture of *Chrysanthemum* and the physical attributes of the soil. Agrarian,1: 21-35.
De Lucia, B., Cristiano, G., Vecchietti, L. Rea, E. and Russo, G. 2013. Nursery growing media: agronomic and environmental quality assessment of sewage sludge-based compost. Applied and Environmental Soil Science Volume 2013, Article ID 565139, 10 pageshttp: //dx. doi. org/10.1155/2013/565139.
Dewayne, L.I., Richard, W.H. and Thomas, H.Y. 1993. http://university.uog.edu/ cals/people/ Pubs/ CN00400.pdf
El-Naggar, H. and El-Nasharty, A.B. 2009. Effect of growing media and mineral fertilization on growth, flowering, bulb productivity and chemical constituents of *Hippeastrum vittatum*, herb. American Eurasian Journal of Agricultural and Environmental Science, 6(3): 360-371.
Fain, G.B. and Paridon, K.L. 2004. Production of bare root *Ophiopogon japonicus* using calcined clay as a growth substrate. Proceedings of Southern Nursery Association Research Conference, Mississippi,USA, 49: 313.
Fitzpatrick, G. 1981. Evaluation of potting mixes derived from urban waste products.Proceedings of Florida State Horticultural Society,10: 95-97.
Herath, H.E., Krishnarajah, S.A. and Damunupola, J.W.2013. Effect of two plant growth hormones and potting media on an ornamental foliage plant, *Ophiopogonsp*. International Research Journal of Biological Sciences, 2(12): 11-17.
Hettiarachchi, C.S., Kumar, P.S., Abayasekara, C.L., Kumara, R.K.G.K., Ekanayake, E.M.H.G.S. and Kulasooriya, S.A. 2010. Cross inoculation response of *Vignaradiata* and *Vignamungo* with Rhizobia from wild non-edible legumes. Proceeding of the Peradeniya University Research Sessions, Sri Lanka,15.
Ingels, J.E. 2004. Ornamental horticulture: Science operations & management. 3rd edition, pp.20-33. State University of New York, College of Agriculture and Technology Cobleskill, New York.
Kapugama, D.D.I. and Peiris, S.E. 2010. Identifying a most suitable growing medium and fertilizer combination for the *Anthurium* cv 'Tropical Red'. National Symposium on Floriculture Research. Department of National Botanical Gardens, Sri Lanka, 76-82.
Kiran, M., Baloch, J., Waseem, K., Jilani, M.S. and Khan, M.Q. 2007. Effect of different growing media on the growth and development of Dahlia (*Dahlia pinnata*) under the agro-climatic condition of Dera Ismail Khan. Pakistan Journal of Biological Sciences, 10 (22): 4140-4143.
Liu, C. H., Liu, Y., Fan, C. and Kuang, S.Z. 2013. The effects of composted pineapple residue return on soil properties and the growth and yield of pineapple. Journal of Soil Science and Plant Nutrition, 13 (2): 433-444.
Rademacher, I. F. and Nelson, C.J. 2001. Nitrogen effects on leaf anatomy within the intercalary meristems of tall fescue leaf blades. Annals of Botany,88(5): 893-903.
Rubasinghe, M.K., Amarasinghe, K.G.K.D. and Krishnarajah, S.A. 2009. Effect of rooting media, naphthalene acetic acid and gibberellic acid (GA_3) on growth performances of *Chiritamoonii*. Ceylon Journal of Science (Biological Sciences), 38 (1): 17-22.
Seran, T.H., Srikrishnah, S. and Ahamed, M.M.Z. 2010. Effect of different levels of inorganic fertilizers

and compost as basal application on the growth and yield of onion (*Allium cepa* L.). The Journal of Agricultural Sciences, 5(2): 64-70.

Taiz, L. and Zeiger, E. 1991. Plant physiology. The Benjamin Cummings Publishing Company, Inc. Califonia. United States Department of Agriculture. 2013. http://plants.usda.gov/ java/ profile?symbol=OPHIO3

Vidhana Arachchi, L.P. and Somasiri, L.L.W. 1997. Use of coir dust on the productivity of coconut on sandy soils. Cocos,12: 54-71.

Wang, M., Zheng, Q., Shen, Q. and Guo, S. 2013. The critical role of potassium in plant stress response. International Journal of Molecular Science, 14: 7370-7390.

Wilson, S.B., Stoffella, P.J. and Graetz, D.A. 2001. Use of compost as a media amendment for containerized production of two subtropical perennials. Journal of Environment Horticulture, 19: 37-42.

Ye, M., Guo, D. Ye, G. and Huang, C. 2005. Analysis of homoisoflavonoids in *Ophiopogon japonicus* by HPLC-DAD-ESI-MSn. Journal of American Society Mass Spectrometry,16: 234-243.