ISSN 0258-7122 (Print), 2408-8293 (Online)
Bangladesh J. Agril. Res. 46(4): 435-443, December 2021

EFFECT OF SUBSTRATES ON GROWTH, YIELD AND QUALITY OF ANTHURIUM IN SOILLESS CULTURE

K. A. ARA[1], M. T. RASHID[2], K. KABIR[3], M. A. SADIA[4] AND S. M. SHARIFUZZAMAN[5]

Abstract

An experiment was conducted at the Floriculture Shade Net House under Horticulture Research Centre of Bangladesh Agricultural Research Institute, Gazipur during 2020-21 to evaluate the effect of different substrates on growth, flowering, yield and quality of anthurium. Six treatments were used viz,. T_1: Soil (control), T_2: Cocodust, T_3: Perlite, T_4: Sawdust, T_5: Cocodust + Perlite (1:1), and T_6: Cocodust + Sawdust (1:1). The experiment was laid out in Completely Randomized Design with five replications. The result showed that Cocodust + perlite (1:1) followed by Cocodust singly performed the best in respect of growth, flower number and quality characteristics of anthurium. Poor performance of all characteristics of anthurium was exhibited in control treatment. Gross return and BCR was the highest in T_5 treatment. The result suggested that Perlite + Cocodust (1:1 ratio) followed by Cocodust (100%) could be used for flower yield maximization and quality improvement of anthurium in pot cultivation.

Keywords: Anthurium, cocodust + perlite, sawdust, growth, flowering, BCR.

Introduction

Anthurium is a highly praised flowering plant which belongs to the Araceae family (Singh *et al*., 2019). It is considered as a promising and valuable cut flower crop next to rose, ranks fifth among top ten cut flowers of the world market (Bose and Yadav, 2015). Anthurium has been recently introduced in Bangladesh and gaining its demand day by day. It has wide ranges of form, size and colour. Anthuriums are now cultivated for dramatic indoor garden display, home decoration, cut-flowers, bedding, floral arrangement and other useful purposes (Singh *et al*., 2019). In city area, there is a little or no longer space for flower garden. Therefore, demand for pot cultured plants and flowers for house decoration as well as roof gardening has immensely increased in recent years. Soil alone as a growing medium does not fulfill all requirements for its higher yield and quality. The introduction of the soilless medium has brought radical change in its protected cultivation and is gaining importance day by day. Anthurium grows well in substrates such as coco peat, cocodust, vermi-compost, perlite etc. (Sindhu *et al.*, 2010). The cocodust, perlite and sawdust have been identified as an agricultural by-product which can be

[1]Ex. Director, TCRC, Bangladesh Agricultural Research Institute (BARI), Gazipur, [2]Scientific Officer, Floriculture Division, HRC, BARI, Gazipur, [3]Associate Professor, Dept. of Horticulture, SAU, Dhaka, [4]MS Student, Dept. of Agroforestry & Environ. Sci. SAU, Sher-E-Bangla Nagar, Dhaka, [5]Ex. Director, ORC, BARI, Gazipur, Bangladesh.

a suitable substrate component for flower crops (Buck and Evans, 2010; Paramveer and Chawla, 2011). Growing in artificial substrates has many advantages over soil as mixtures contain the same composition, diseases and weed free, light in weight and porous (Nowak and Strojny, 2004) with low salt content, good water-holding capacity, ion exchange capacity and near neutral pH (Singh *et al*., 2019). So, keeping the above facts in view, an attempt was made to study the performance of different substrates on growth, flowering and economics of anthurium.

Materials and Methods

A pot experiment was conducted in the Floriculture Shade Net House under Horticulture Research Centre of Bangladesh Agricultural Research Institute, Gazipur during 2020-21. Six weeks old hardened tissue cultured plantlets of anthurium var. BARI Anthurium-1 were used as planting material. Twenty five cm of plastic pots were taken for the experiment. Four different potting substrates viz., soil, cocodust, perlite and sawdust were used as treatment variables. The treatment combinations were: T_1: Soil (control), T_2: Cocodust, T_3: Perlite, T_4: Sawdust, T_5: Cocodust + perlite (1:1), and T_6: Cocodust + sawdust (1:1). The experiment was laid out following Completely Randomized Design (CRD) with five replications. Before setting of the experiment, the chemical composition of potting substrates were analyzed following standard method as outlined by Page *et al.* (1982). The chemical properties are presented in Table 1 and Table 2. Well-decomposed saw dust, perlite and cocodust were used singly and combined before 25 days of seedling transplanting. The seedlings of anthurium were transplanted singly in the respective treatment pot on 20 January 2020. The anthurium plants were nourished with Cooper's nutrient solution (All in ppm: Nitrogen (N) 220-236, Phosphorous (P) 60, Potassium (K) 300, Calcium (Ca) 170-185, Magnesium (Mg) 50, Sulfur (s) 68, Iron (Fe) 12, Copper (Cu) 0.1, Zinc (Zn) 0.1, Manganese (Mn) 2.0, Boron (B) 0.3, Molybdenum (Mo) 0.2) having EC of 1.5 dS/m throughout the growing period. Irrigation / water was applied as and when required. Data on survivability (%), plant height, number of leaves, plant spread, sucker number, days to flowering, flower number, stalk length, flower weight, vase life and flowering duration were recorded from five randomly selected plants of each treatment and averaged. Treatment wise post-harvest potting substrates were analyzed following same method (Page *et al*., 1982). Data were statistically analyzed with the help of MSTAT software. Difference between treatments means were compared by Duncan's Multiple Range Test (DMRT) according to Steel *et.al*, (1997). The benefit cost ratio (BCR) was calculated for each treatment pot. Total variable costs were calculated by adding the cost incurred for labor and inputs for each treatment. Flower stick and sucker of anthurium were utilized to calculate gross return. Shadow prices (sucker and others) were not considered. Gross return was estimated by multiplying following flower stick and sucker yield by unit price (farm gate) of anthrium flower and sucker. Gross margin was calculated by subtracting total variable cost from gross return.

Table 1. Chemical properties of different potting substrates (initial)

Materials	pH	OM (%)	Ca	Mg	K	Total N (%)	P	S	B	Cu	Fe	Mn	Zn
			(meq/100g)				(µg/g)						
Cocodust	7.5	28	1.1	0.3	1.5	1.65	1.0	2.0	0.015	0.005	0.80	0.020	0.012
Perlite	7.4	25	0.9	0.3	1.2	1.60	0.8	1.8	0.010	0.004	0.40	0.090	0.010
Sawdust	6.6	20	0.8	0.2	1.1	1.40	0.5	1.6	0.004	0.001	0.20	0.005	0.008

Table 2. Chemical properties of initial soil (potting substrate)

Materials	pH	OM (%)	Ca	Mg	K	Total N (%)	P	S	B	Cu	Fe	Mn	Zn
			(meq/100g)				(µg/g)						
Soil (Sandy loam)	7.2	0.50	13.0	3.0	0.20	0.03	11.0	10.0	0.18	1.10	20.0	17.0	0.90
*Critical level	-	-	2.0	0.5	0.12	0.10	8.0	8.0	0.16	0.20	3.0	1.0	0.50

*FRG (2018).

Results and Discussion

Effect of substrates on survivability and growth parameters of anthurium

Different potting substrates affected the percent survival of anthurium plantlets (Figure 1). Among different treatments, T_5 (cocodust + perlite @ of 1:1) showed 100% survivability of the plants followed by T_2 (only cocodust) with 90% survivability. The reason for the best performance might be due to cocodust with the perlite is having the higher organic matter content, which increased water holding capacity and nutrient availability for easy uptake by the plant. The lowest survivability percentage (70%) was noted from T_1 (only soil) treatment. Similar observation was reported by Sharifuzzaman *et al.* (2010) in euphorbia house plant.

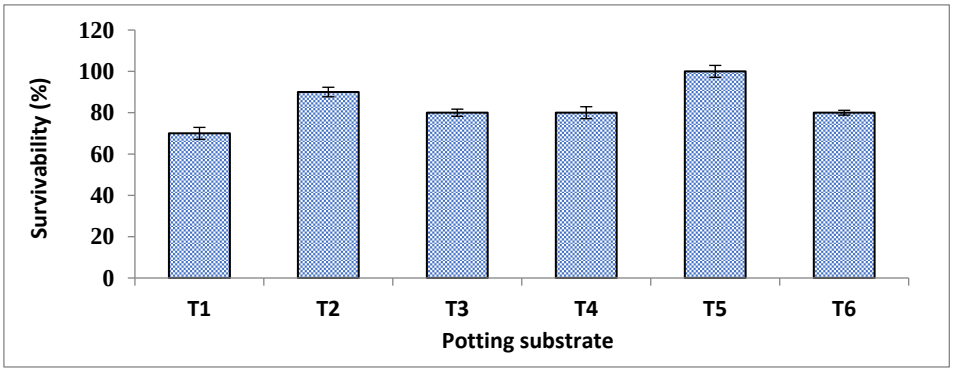

Fig. 1. Effect of potting substrates on survivability of anthurium. Error bars represent the standard error, Note: T_1: Soil (control), T_2: Cocodust, T_3: Perlite, T_4: Sawdust, T_5: Cocodust + perlite (1:1), and T_6: Cocodust + Sawdust (1:1).

Data on the plant height from Table 3 exhibited that the maximum plant height (52.0 cm) was measured in the treatment T_5 (cocodust + perlite) which was statistically similar to most of the treatments. The shortest plant (45.0 cm) was in T_1 treatment. Most of the potting substrates especially cocodust (T_2) and cocodust + perlite (T_5) contained more organic matter in decomposed form which release essential plant nutrient particularly nitrogen that accelerated the plant growth. Meyer and Anderson (2003) reported that nitrogen enhances cell division and formation of more plant tissues resulting in luxuriant vegetative growth and thereby increased plant height. The number of leaves per plant was significantly influenced by different potting substrates / media (Table 3). Maximum number of leaves per plant (8.00) was recorded from substrate amended with cocodust (T_2) comparable with most of the treatment. The increase in number of leaves per plant might be due to cocodust enabled better aeration, moisture holding capacity and nutrient retention (Khan *et al*., 2019). However, adequate number of leaves is essential for normal plant growth and production. Similar result was reported by Sindhu *et al.* (2010) in gerbera. The substrate amended only with soil (T_1) recorded the minimum number of leaves per plant (4.5). The result revealed that there was a significant difference in plant spread among the treatments (Table 3). Maximum plant spread (30.5 cm) was observed in T_2 which was statistically identical to T_5, T_3 and T_6 treatment. Minimum plant spread (20.9 cm) was observed in T_1 (only soil) treatment. The maximum number of suckers per plant (4.8) was found in T_5 treatment which was statistically similar with most of the treatments and the lowest (2.5) in T_1 treatment. Saha *et al.* (2018) also reported that perlite and cocodust (1:1) (T_5) and cocodust (100%) (T_2) contain higher amount of plant nutrient and have potential for restoration of soil fertility resulting increase number of suckers per plant. This finding is in agreement with the findings of Thangam *et al.* (2009) who obtained that maximum number of suckers in gerbera, when the potting substrate was cocodust + perlite.

Table 3. Effect of potting substrates on growth parameters of anthurium

Treatments	Plant height (cm)	Number of leaves/plant	Plant spread (cm)	Number of sucker/plant
T_1	45.0b	4.50b	20.9 c	2.50b
T_2	50.0ab	8.00a	30.5 a	4.00ab
T_3	49.0ab	6.50ab	27.9ab	3.50ab
T_4	48.8ab	6.00ab	25.7 b	3.30ab
T_5	52.0a	6.70ab	30.0 a	4.80a
T_6	49.0ab	6.00ab	27.2 ab	3.40ab
CV (%)	5.9	6.9	7.5	8.7

Means within the same column with an common letters differed significantly ($P \leq 0.05$) by DMRT. T_1: Soil (control), T_2: Cocodust, T_3: Perlite, T_4: Sawdust, T_5: Cocodust + Perlite (1:1, v/v), and T_6: Cocodust + Sawdust (1:1, v/v).

Effect of substrates on flower parameters of anthurium

Variation was observed regarding the number of flowers per plant (Figure 2). The number of flowers per plant varied from 4.0-8.0 across the treatments. Flowering is a complex process in plant's life for which the plants require essential nutrients from optimum and suitable substrate for growth and produce higher number of flowers. The maximum number of flowers per plant (8.0) was recorded from T_5 followed by T_2 (6.0) treatment. Plants of the treatment T_1 produced the lowest number of flowers (7.0). Maximum number of flowers was also obtained using cocodust alone or cocodust with perlite reported by Pivot (1989) in gerbera. Considering the chemical properties of different potting substrates, T_5 (cocodust + perlite) and T_2 (cocodust) provided higher amount of N, P, K, B and Zn nutrient (Table 2). This is corborates with the findings of Ahmad *et al*. (2012) and Keshev and Dubey (2008) in gerbera and anthurium production.

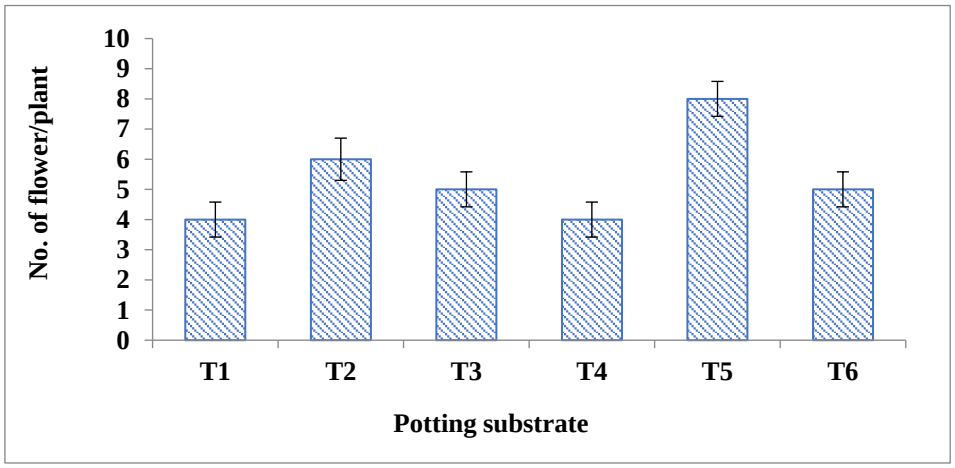

Fig. 2. Effect of potting substrates on number of flowers per plant in anthurium. Error bars represent the standard error, Note: T_1: Soil (control), T_2: Cocodust, T_3: Perlite, T_4: Sawdust, T_5: Cocodust + Perlite (1:1), and T_6: Cocodust + Sawdust (1:1).

Days to flowering were significantly affected by different potting substrates (Table 4). Plants took more time (74 days) for flowering in T_1 treatment where the nutrients availability was restricted i.e. T_1 (only soil). On the other hand, plants grown in nutrient enriched media took less time for flowering that means 64 and 65 days for flowering in T_2 (cocodust) and T_5 (cocodust + perlite), respectively. Present results are in agreement with the findings of Ahmad *et al.* (2012) where the mixture of cocodust + perlite and cocodust singly resulted early flowering in gerbera. Stalk length of anthurium influenced significantly by different potting substrates (Table 4). The treatment T_5 produced the longest stalk (25.0 cm) which was followed by T_2, T_3 and T_4 treatment and shortest stalk

observed from T_1 followed by T_6 treatment (Table 4). Ahmed *et al.* (2012) reported similar that the longer flower stalks of rose were achieved in the substrate combination of perlite with coco fiber. The media cocodust singly or along with perlite had more phosphorus content which was facilitated to produce longer and thicker stalks of anthurium as compared to other treatments. Phosphorus is the key nutrient involved in stimulating and enhancing the bud development and blooming (Ji Kim and Li, 2016). The mentioned findings also confirmed by the findings of Meyer and Anderson (2003) who observed that thick flower stalks of gladiolus and lily grown in nutrient rich various media like cocodust along with perlite. Significant variation was observed in respect of stalk weight among the substrates (Table 4) where the maximum stalk weight (27.0g) was recorded from the treatment T_5 which was statistically similar with T_2 (25.0g) treatment. The lowest stalk weight (16.0 g) was obtained from T_1 treatment. More or less similar results were reported by Pivot (1989) in gerbera. The parameter vase life is related to post-harvest handling of cut flowers. This is one of the most important commercial aspects of anthurium production. The longer vase life (20.0 days) was found from the plants grown in T_5 (cocodust + perlite) comparable with most of the treatments. The shorter (14.0 days) vase life was recorded from the plants grown in T_1 (soil). Ahmad *et al.* (2012) also reported similar results who stating that the combination of cocodust + perlite had eventually increased the vase life of gerbera flower.

Table 4. Effect of different potting substrates on flower parameters of anthurium

Treatments	Days to flowering	Stalk length (cm)	Stalk weight (g)	Vase life (days)
T_1	74.0a	19.8b	16.0 c	14.0 b
T_2	64.0c	23.7 ab	25.0 ab	17.8 ab
T_3	68.0bc	23.0 ab	18.8 bc	15.8 ab
T_4	70.0b	22.0 ab	17.5 bc	15.5 ab
T_5	65.0c	25.0 a	27.0 a	20.0 a
T_6	70.0b	20.0 b	22.0 b	15.9ab
CV (%)	8.1	6.9	7.8	7.6

Means within the same column with a common letters differed significantly ($P \leq 0.05$) by DMRT. Note: T_1: Soil (control), T_2: Cocodust, T_3: Perlite, T_4: Sawdust, T_5: Cocodust + Perlite (1:1, v/v) and T_6: Cocodust + Sawdust (1:1, v/v).

Maximum flowering duration of anthurium of 28 days was observed in cocodust with perlite media (T_5) followed by 25 days of flowering duration in substrate containing cocodust singly (T_2). Dutta *et al.* (2002) was also obtained similar results in gerbera where higher duration from full bloom to flower deterioration was observed in plants grown in cocodust substrate. The increased flowering

duration might be attributed to helpful conditions in the substrate T_2 and T_5. The minimum flowering duration of 23 days was recorded in T_1 (soil).

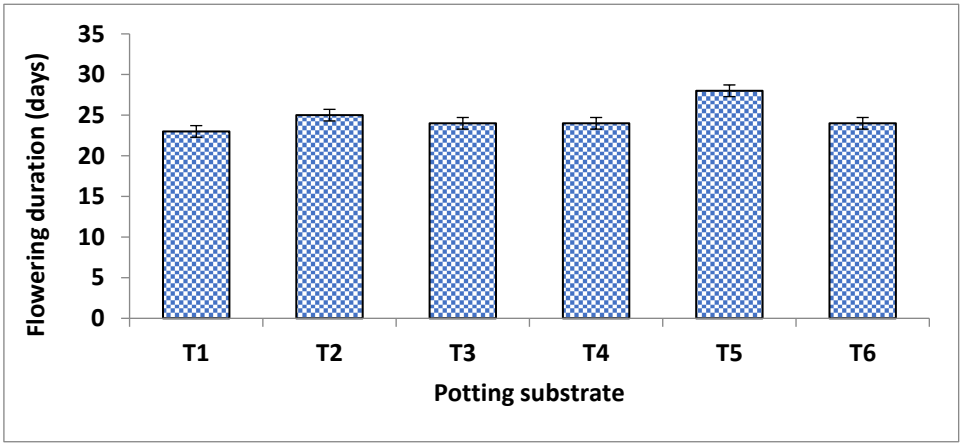

Fig. 1. Effect of potting substrates on flowering duration (days) of anthurium. Error bars represent the standard error, Note: T_1: Soil (control), T_2: Cocodust, T_3: Perlite, T_4: Sawdust, T_5: Cocodust + Perlite (1:1), and T_6: Cocodust + Sawdust (1:1).

Nutrient status in post-harvest potting substrates

Most of the nutrients showed variation among the treatments (Table 5). The maximum organic matter (9.80%) was obtained from T_5 followed by T_2 treatment and lowest from T_1 treatment. Total N content was higher (0.45%) in T_2 treatment followed by T_5 treatment. Table 5 indicated that most of the nutrient content exhibited comparatively higher in cocodust alone (T_2) or cocodust + perlite (1:1) (T_5) treatment than the other treatments (Table 5).

Table 5. Nutrient status in post-harvest potting substrates

Treatments	pH	OM (%)	Ca	Mg	K	Total N (%)	P	S	B	Cu	Fe	Mn	Zn
			(meq/100g)				(µg/g)						
T_1	7.7	0.45	12.0	3.2	0.15	0.024	10.5	12.0	0.015	1.0	19	17	2.0
T_2	7.0	9.75	10.5	2.5	0.38	0.450	14.3	15.0	0.070	1.2	30	12	2.3
T_3	7.6	8.00	10.0	2.3	0.28	0.250	13.0	13.0	0.050	1.8	36	13	2.4
T_4	7.8	5.50	8.5	2.0	0.26	0.035	12.5	12.5	0.023	1.7	40	25	2.3
T_5	7.2	9.80	10.8	2.6	0.35	0.400	14.0	15.2	0.075	1.3	35	14	2.5
T_6	7.7	6.10	9.0	2.5	0.25	0.010	13.0	13.0	0.030	0.7	48	25	2.3

Note: T_1: Soil (control), T_2: Cocodust, T_3: Perlite, T_4: Sawdust, T_5: Cocodust + Perlite (1:1, v/v), T_6: Cocodust + Sawdust (1:1, v/v).

Effect of potting substrates on cost and return analysis

Application of different substrates in pot had a positive impact on gross return of anthurium (Table 6). The highest increase of gross return and gross margin were from application of cocodust with perlite (T_5) in pot. Both were the lowest from T_1 treatment. The calculated benefit cost ratio (BCR) was the highest (2.36) in T_5 treatment.

Table 6. Effect of different potting substrates on partial economics of anthurium

Treatments	TVC (Tk. /pot/yr.)	Gross return (Tk. /pot/yr.)	Gross margin (Tk. /pot/yr.)	BCR
T_1	1533	1900	367	1.24
T_2	1540	3000	1460	1.95
T_3	1545	2600	1055	1.68
T_4	1540	2380	840	1.54
T_5	1543	3680	2137	2.38
T_6	1540	2540	1000	1.65

Note: T_1: Soil (control), T_2: Cocodust, T_3: Perlite, T_4: Sawdust, T_5: Cocodust + Perlite (1:1, v/v) and T_6: Cocodust + Sawdust (1:1, v/v).

Inputs price: Plastic pot= BDT 30/pot, Sandy loam soil= BDT 3/pot, Wage rate= BDT 100/hour, Autostin= BDT 160/100g, Ripcord=BDT 130/100ml, Output price: Flower stick=BDT 100/stick, Sucker= BDT 400/sucker, TVC= Total variable cost..

Conclusion

All the substrates used in the experiment, cocodust + perlite (1:1) was the best and suitable potting substrate followed by cocodust (100%) on the basis of growth, yield, and flower parameters of anthurium as well as economic benefit. So, the result suggests that perlite + cocodust (1:1 ratio) followed by cocodust (100%) could be used for flower yield maximization and quality improvement of anthurium in pot cultivation. This finding can support the urban people and commercial entrepreneurs for successfully cultivation of anthurium.

Acknowledgement

The authors are grateful to NATP-2, BARC funded “Development of Production Package for Horticultural Crops in Rooftop and Open Space in Urban Areas of Bangladesh” sub-project for financial support to conduct the research.

References

Ahmad, T., A. Gulfar and M. Saleem. 2012. Growth and flowering of gerbera as influenced by various horticultural substrates. *Pakistan J. Bot*., **44**: 291-299.

Bose, T. K. and L. P. Yadav. 2015. Anthurium, Naya Prokash. 206 Bidhan Sarani, Calcutta 700006, India. p. 452.

Buck, J. S. and M. R. Evans. 2010. Physical properties of sawdust used as a horticulture substrate. *Hort. Sci*. **45**: 643-649.

Dutta, M., M. T. Patil and K. Sonawane. 2002. Effect of various substrates on growth and flowering of chrysanthemum. *Indian J. Hort*. **59** (2): 191-195.

FRG, 2018. *Fertilizer Recommendation Guide-2012*. Published by Bangladesh Agricultural Research Council, Dhaka, Bangladesh.

Ji Kim H. and X. Li. 2016. Effects of phosphorus on shoot and root growth, partitioning, and phosphorus utilization efficiency in Lantana. *Hort. Sci*. **51**(8): 1001-1009.

Keshav, K. and P. Dubey. 2008. Effect of substrates on anthurium culture. Asian J.Hort. **3**(1):165-166.

Khan, M., M. D. Era, M. Islam, R. Khatun, A. Begum and S. M. Billah. 2019. Effect of coconut peat on the growth and yield response of *Ipomoea aquatica*. *Amer. J. Plant Sci.* **10**: 369-381.

Meyer, S. and P. Anderson. 2003. Nitrogen and phosphorus leaching during the decomposition of broadleaf forest litter. *Polish J. Soil Sci.* **36**(1): 21-29.

Nowak, J. S. and Z. Strojny. 2004. Effect of physical properties of organic growing media on cut flower yield of gerbera. *J. Agric. Sci*. **94**: 133-138.

Page, A. L., R. H. Miller, and D. R. Keeney. 1982. Agronomy Series 9 ASA, SSSA. Methods of Soil Analysis (Part 2, 2nd ed., pp. 403-427). *Amer. Soc. Agron.* Madison, USA.

Paramveer, S. and S. L.Chawla. 2011. Standardization of growing medium for anthurium cv. Flame under protected conditions.Indian J. Hort. **68** (1):86-90.

Pivot, D. 1989. Substrates of quality flower production of gerbera. *Acta Hort.* **172**: 211-222.

Saha, S. M., C. Talukdar and D. B. Phookan. 2018. Effect of growing media and depth on rooftop cultivation of gerbera cv. Red Gem. *Int. J. Curr. Microbial. App. Sci.* **7**(5): 35-39.

Sharifuzzaman, S. M., K. A. Ara, K. Kabir and T. L. Shapla. 2010. Effect of potting media on the growth and yield of Euphorbia. *Bangladesh J. Agric*. **3**(2): 165-169.

Sindhu, S. S., D. B. Gholap, M. C. Singh and M. R. Dhiman. 2010. Effect of medium amendments on growth and flowering in gerbera. *Indian J. Hort*. **67**: 391-394.

Singh, P., A. Arha and A. Bhardwaj. 2019. Role of growing medium in yield and quality of anthurium: A Review. *Agric. Rev.* **9**(40): 229-233.

Steel, R. G. D., J. H. Torrie and D. A. Dickey. 1997. Principles and Procedures of Statistics. MC. GrawHil Book Co. New York. pp. 107-109.

Thangam, M., M. S. Ladaniya and V. S. Rorikanthimath. 2009. Performance of gerbera varieties in different growing media under coastal humid conditions of Goa. *Indian J. Hort.* **66**(1): 79-82.