Plant Archives Volume 20 No. 2, 2020 pp. 6001-6009 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

GROWING MEDIA INFLUENCE ON THE GROWTH AND DEVELOPMENT OF *ROSA HYBRIDA*

Mohammad Moneruzzaman Khandaker*, Aimi Fatini, Mahmoud Dogara Abdulrahman, Umar Aliyu Abdullahi and Noor Afiza Badaluddin

[1]School of Agriculture Science and Biotechnology, Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin, Besut Campus, 22200 Besut, Terengganu, Malaysia.

Abstract

A study was carried out to investigate the effects of various growing media on the reproductive and vegetative rose plants growth. The rose seedling was collected from a commercial nursery, located at Kuala Terengganu, Malaysia. Five growing media (Bris soil + perlite as control, agropolis media, microbial media, garden soil media, and Garden soil + poultry manure) were used. The tryout was set in accordance with Completely Randomized Design (CRD) with 4 replicates. Garden soil with addition of poultry manure showed the best growing media for the production of *Rosa hybrida* in terms of the number of flowers, total soluble solids content of leaf, the diameter of flower, the length of petal, the number of petals, the length of root and the carotene content of the rose petal. Flower longevity in potted rose plants was also highest in garden soil plus poultry manure media. There was a linear correlation among flower number, leaf TSS content and between flower longevity with leaf TSS content in potted rose plants. Results of the study provided how the growth and development quality of cut flower production in *Rosa hybrida* could be improved.

Key words : Growing media, Growth and Development and *Rosa hybrida.*

Introduction

Rose, the queen of flowers, is demand for its beauty and many other uses such as production of petals, making rose oil (Attar), rose water, rose wine, rose marmalade (Gulkand), rose jam, rose crystallized petals, rose honey, extraction of perfumes, extraction of vitamin C from hips, for medicinal uses and for sale as cut flower (Khan *et al.,* 2004). They have high economic value in the international market. The genus of rose plant is diversified across mild weathered regions of hemisphere including North America, Europe, Asia, and the Middle East, with the greatest diversity of species found in western China (Younis and Riaz, 2005). Genus Rose comprises more than 200 species and 18,000 cultivars that has since been used as vibrant plant in floriculture industry. (Kiran *et al.,* 2007). About $10 billion are spent annually to cut flowers, potted plants and garden plants. (Guterman *et al.,* 2002). As established by FAO statistics in 2005, the aggregate world production of comestible rosaceous fruits is about 113 million tonnes. At a very conservative farm gate value of US$400 per tonne, this translates to $45 billion. Addition to the world value of almond, expurgated rose plants, and other goods suggest that rosaceous plants could be worth at least $60 billion annually at the farm gate (Hummer and Janick, 2009). Their exceptional importance economically is attributed by the use of their petals as a spring of natural fragrance and flavoring. The damask rose (*Rosa damascena*) is the most important species used to produce rose water, attar of rose, and essential oils in the perfumery industry (Guterman *et al.,* 2002). There are two main prospects of production of roses, *i.e.*, food products and cut flowers (Stein *et al.,* 2009). The peak integral products are rose water, rose oil and cut flower. They have excellent economic relevance in the international market. Rose products are usually used in cosmetic, perfume, and the pharmaceutical industry (Baydar, 2006). In recent era, the direction has shifted to focus on the form and color of bud with the consequence of fragrance losing the emphasis.

***Author for correspondence :** E-mail: moneruzzaman@unisza.edu.my

Holland (65%), Colombia (13%), Israel (8%), Italy (7%), etc. and importers are Germany, USA, and France, UK, and Gulf countries (Hussain and Khan 2016) are the major rose exporters in the world.

Cutting stem as method of propagating is by far the most frequently used routine of reproducing roses. The rooting percentage and survival rate of the rose cultivation some time is very low due to the use of inappropriate growing media. The growing media can regulate the rooting percentage and improve the success rate of stem cuttings (Copping and Menn, 2000). The success rate of rose production is sometimes very low due to lower moisture and nutrient contents in the growing media. The challenges of identification of suitable novel growing media are still emphasized in rose production appropriate potting media for the quality (Cardellina, 2002). Khandaker *et al.,* (2019) reported that peatmoss and cocopeat growing media improved the growth, quality and longevity of potted petunia flowers under greenhouse condition. Growing media always take integral part in the growth and quality of pot plants. Rose is one such a classical plant requires a good media for better growth and quality of flower production. Nutritional status, water holding capacity and aeration are Physiochemical properties of media that facilitate growth as reported by Riaz *et al.,* (2008). This study will explore the significant impact of media on the growth and development of rose plants. In this study, we investigated the effect of growing media on growth and developments of rose production. The findings of the study had a great significant value in the growth and development of flowering plant as well as in the floriculture industry.

Materials and Methods

Rose (*Rosa hybrida*, red cultivar) was used in this study. The rose seedling was collected from a commercial nursery located at Kuala Terengganu, Malaysia. Other materials included different types of growing media (perlite, BRIS Soil, Agropolis media, Microbial media, Garden soil media, and Poultry manure), and white gardening pot were collected from field research office, University Sultan Zainal Abidin, Besut Campus, Terengganu, Malaysia.

Media preparation and transplanting of rose seedlings

The study was conducted in research plot and laboratories of the Faculty of Bioresources and Food Industry, University Sultan Zainal Abidin, Campus Besut, 22200 Besut, Terengganu. The potted rose seedling was selected from one of the nurseries in Kuala Terengganu, based on their popularity, availability, aesthetic value, and commercial value. The seedling was then transferred into a white pot contained different types of media for the treatments. The plants were watered twice a week and the inspection of pest and disease was made during watering the plants. Five different growing media was prepared which were BRIS Soil + Perlite as a control, Agropolis media, Microbial media, Garden Soil media, and Garden soil + poultry manure for transplanting the rose seedlings. The seedling of rose plants was transplanted into the white garden pot at uniform size and age.

Experimental Delineate

The experiment was conducted according to Completely Randomized Design (CRD) with 4 replicates. There were 5 treatments including control that conducted for a total of 20 potted rose plants in the experiment. The different type of growing media refer to table 1 below.

Measurements of morphological parameters

Leaves, flowers and petals numbers and flower longevity manually counted and observed during the experimental period. The length of petals, the diameter of flower, and length of the root was measured manually using a measuring ruler (Khandaker *et al.,* 2019).

Determination of chlorophyll and leaf Total Soluble Solid (TSS) content

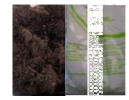
Chlorophyll content (SPAD value) was measured by using the SPAD-502 portable chlorophyll meter (Minolta, Japan). The SPAD-502 meter was a lightweight meter that was widely used as a non-destructive method to determine the chlorophyll content of the leaves that was done by clamped the leaf and the meter will show the indexed of the chlorophyll content. Five (5) leaves per replicate were selected randomly and the average was taken for each replicate. Use of hand held refractometer was employed to measure the leaf TSS content. The leaf sample of each replicate was collected and weighted by using the electrical balance of a reading of 0.5 gram to be crushed with mortar and pestle to extract the leaf juice. The leaf juice was dropped into the sensor of the refractometer by using the dropper and the reading was taken and recorded (Khandaker *et al.,* 2019).

Determination of the fresh and dried weights of the shoot and root of plants

The whole plant was aloof from the white pot and the root part was cleaned by using tap water. The fresh weight of the plant was taken by using a weighing balance and then dried for 24 hours at 60^{o}C. Both the shoot and root of fresh and dried weights were recorded.

Determination of the anthocyanin and carotenoid

Table 1: Different types of media used in this study.

Treatment	Type of media used	
Treatment 1 (control)	BRIS Soil + Perlite (1/2 :1/2)	
Treatment 2	Agropolis media	
Treatment 3	Microbial media(Bio-S Microbial organic fertilizer	
Treatment 4	Garden soil media	
Treatment 5	Garden soil + Poultry manure (1/2:1/2)	

content

The content of anthocyanin in petal was determined by differential pH method (Rodríguez-Saona *et al.,* 1999). Samples were diluted to ratio of 1:4 with two different pH buffer solutions; 0.025M potassium chloride, pH 1.0; and 0.4M sodium acetate, pH 4.5. The pH was adjusted using concentrated hydrochloric acid. The samples were measured with absorbance at 530 nm and 700 nm by using water as blank. The different of absorbance between pH 1.0 and pH 4.5 samples was calculated by using spectrophotometer as follows:

$$A = (A_{530nm} - A_{700nm})pH\ 1.0 - (A_{530nm} - A_{700nm})pH\ 4.5$$

The monomeric anthocyanin pigment concentration was calculated by using the following formula. Monomeric anthocyanin pigment (mg/l) =

$$\frac{A \times MW \times DF \times 1000}{\varepsilon \times 1}$$

MW = 449.2, ε = 26900 and DF = Dilution Factor. Carotenoid content will be estimated according to the method described by (Arnon, 1949).

Statistical Analysis

The data obtained from the experiment was analyzed by using SPSS Statistics version 25 software. A one-way analysis of variance (ANOVA) was applied to evaluate significant differences in the studied parameters in the different treatments. Means comparisons were performed with Tukey's test, significance at $p \leq 0.05$.

Results

Number of leaf

The number of the leaves was recorded weekly and the data were presented in fig.1. In week 1, treatment with Agropolis soil contents showed the number of leaves produced is significantly higher than any *Rosa hybrid* grown on other media. Garden media treatment produced the second highest number of leaves, followed by combination of garden soil and poultry manure, then microbial soil and combination of bris soil and perlite respectively (Fig. 1 & 2). Insignificant number of leaves decreases was observed in combination of garden soil and poultry manure and agropolish soil whereas increase in number of leaves in bris and perlite, microbial soil and slightly in garden soil for week 2 were respectively recorded.

Number of Flower

Combination of garden soil and poultry manure media found to support flower production at week 2 which decrease significantly in weeks 3 and 4. In garden soil media, week 1 and 2 lowest flower count with week 1 count found to be higher than week 2 whereas, weeks 3 and 4 has equal and higher flower count. Bris soil and perlite produced flower linearly with increase in weeks. A drastic low count was observed in agropolis media as shown in figure 3 below.

Total Soluble Solids (TSS) of Leaf

TSS of leaves was nonlinearly increasing with weeks. Higher soluble solids counts were recorded significantly higher ($P \leq 0.05$) in week 1 as shown in Fig. 4 below. Level of significance tested connoted that test media produced leaves with high TSS compared with control. However, among the test media, Garden soil mixed with poultry manure yielded better result than any followed by garden soil, agropolis media and microbial media (Fig. 4).

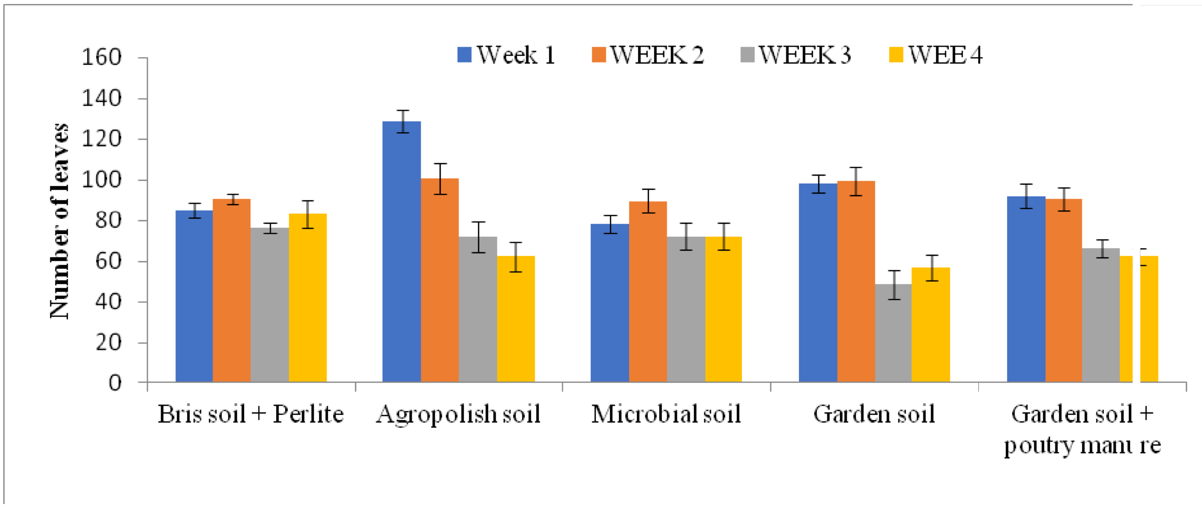


Fig. 1: Growing media effects on the number of rose leaf produced. Bars indicate ± SE.

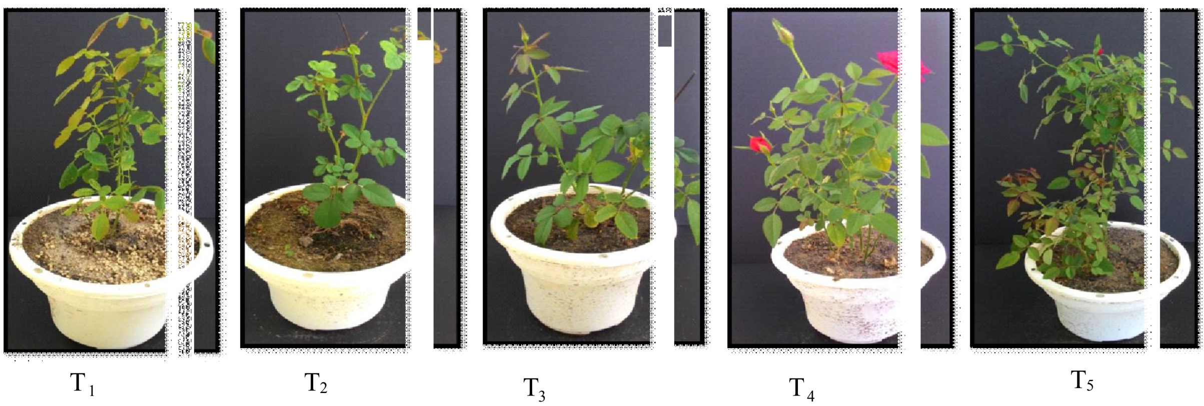


Fig. 2: Growing media effects on vegetative growth of rose plants under potted condition. T= Treatment.

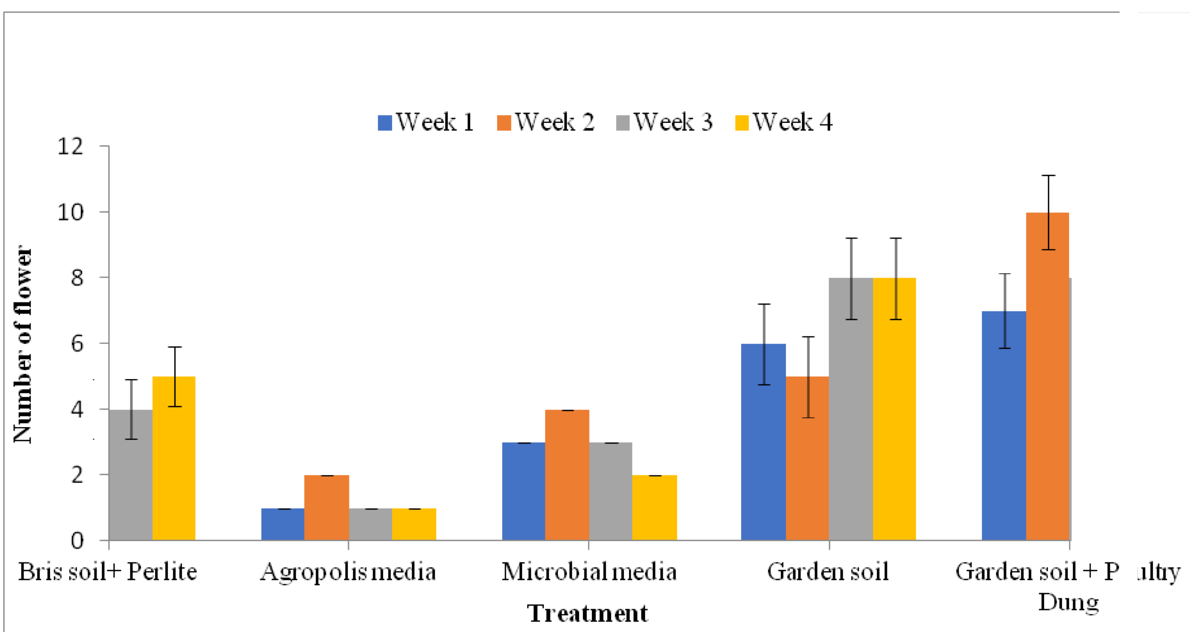


Fig. 3: Growing media impact on the number of flowers produced per plants at different week of observations. Bars indicate ± SE.

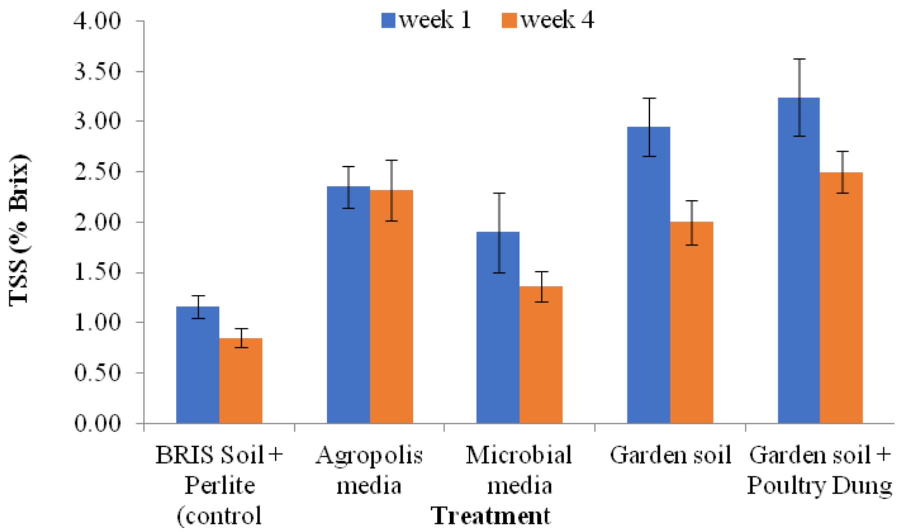


Fig. 4: Effects of growing media on total soluble solids (TSS) of the rose leaf on week 1 & 4. Bars indicate ± SE.

Chlorophyll Content and diameter of flower

The table 2 below shows the chlorophyll content of the rose plant grown on different media used was statistically insignificant (P≤0.05). However, the highest quantity of chlorophyll content was recorded from the control bris in combination perlite soil treatment, followed by microbial media and garden soil in combination with poultry manure, agropolis media. Least and comparable chlorophyll content was recorded in rose pants grown on agropolis media and garden soil also shown in table 2 below. Table 3 clued that a significant difference (p≤0.05) among the width of the flowers with the growing media used was beheld. The treatment of garden soil with poultry manure shows the highest diameter of flower produced while control displays the lowest diameter of flower respectively (Table 3).

Petal Length and Number of Petal

The length of petals recorded at the end of experiment shows that the level of significancy exists among the rose plants grown on different media. All rose plants on test media has petals longer than that of control in comparison (P≤0.05). Garden soil mixed with poultry manure possess plant with largest mean petal length value significantly higher than all other tests. No significance difference observed in rose plant petal grown on microbial and garden soil media shown in table 3 below.

Petals number varies considerably among the tests and control respectively. All test reading determined indicated the higher level of significant differences when compared with control. Among the tests, Garden soil mixed with poultry manure has the number of petals statistically higher than other tests. Number of petals of rose grown on microbial and garden soil media shows no significant difference between, with garden soil having higher mean value (22.5) statistically insignificantly than microbial media. When comparing Agropolis media with microbial media, it was observed that number of petals in rose plant grown microbial media have higher mean value but statistically in significant (Table 2). Flower longevity on the potted rose plant was affected significantly by different dealings. The flower longevity in garden soil with poultry manure treatment was highest whereas, the lowest longevity was noted in control treatment (Table 2).

Root Length and Fresh Weight of Root

The length of roots determine signposted the existence of differences significantly (P≤0.05) among the whole tests and control with rose plant grown on Garden soil mixed with poultry manure having longest mean root value significantly higher than all followed by Garden soil, Microbial media, control and lastly Agropolis media (Table 3). The quality parameters such as fresh weight of root were also important to determine the standard quality of the rose plant produced. The media does not cause any significant differences to the fresh weight of root among the tests and control group. The results showed microbial media recorded the highest. The least fresh weight root was recorded from agropolis media (Table 3).

Dry root weight

Dry weight was determined after drying the root sample. The result determined shows that there were statiscally insignificant differences ($p \leq 0.05$) among the dry root weight grown on their respective media. The rose plant under control treatment showed the highest reading of the dry weight of the root followed by the microbial media and the lowest reading was recorded in

Fig. 5: Effects of disparate growing media on flower diameter of rose under potted condition. T= Treatment.

Table 2: Growing media effect on the chlorophyll content and flower characteristics of rose.

Treatment	Chlorophyll content (SPAD)	Diameter of Flower (cm)	Petal Length (cm)	Number of Petal	Flower longevity (Days)
T_1	35.85 ± 2.5a	2.17 ± 0.14a	1.32 ± 0.14a	13.50 ± 0.75a	12 ± 0.47a
T_2	31.18 ± 2.7a	3.14 ± 0.18b	1.48 ± 0.15b	19.25 ± 0.97b	13 ± 0.45a
T_3	33.78 ± 2.5a	3.49 ± 0.13c	1.59 ± 0.14c	20.50 ± 0.76bc	14 ± 0.43b
T_4	30.32 ± 2.2a	3.57 ± 0.14d	1.56 ± 0.16c	22.25 ± 1.30c	16 ± 0.20c
T_5	32.38 ± 2.9a	3.87 ± 0.243	1.77 ± 0.14d	27.75 ± 0.97d	19 ± 0.11d

Mean ± SE. Values sharing the identical letter were statistically insignificant ($p \leq 0.05$).

Table 3: of growing media effects on the fresh and dry weight of plant and their roots

Treatment	Root length (cm)	Fresh root weight (g)	Dry root weight (g)	Fresh shoot weight (g)	Dry shoot weight (g)
T_1	17.09±0.40^{a}	5.17±0.10^{a}	1.76±0.10^{a}	14.21±0.09^{a}	5.97±0.08^{b}
T_2	13.00±0.33^{b}	1.72±0.14^{a}	0.48±0.08^{a}	6.41±0.09^{a}	1.91±0.10^{a}
T_3	18.10±0.34^{c}	6.85±0.19^{a}	1.66±0.09^{a}	21.24±0.39^{b}	7.23±0.10^{b}
T_4	19.27±0.51^{d}	4.96±0.14^{a}	0.77±0.08^{a}	20.71±0.10^{b}	7.28±0.08^{b}
T_5	20.96±0.29^{e}	3.05±0.10^{a}	1.42±0.14^{a}	18.36±0.09^{b}	5.76±0.09^{b}

Mean ± SE. Values sharing the similar letter were insignificant statistically at $p \leq 0.05$.

agropolis media (Table 3).

Fresh and dry weight of shoot

The results showed that the fresh weight of rose plant shoot was significantly poshed by the different growing media used (Table 3). The garden soil with addition of poultry manure showed the highest results while the agropolis media showed the lowest readings in the fresh weight of the shoot produced. This might essentially from the good health of plant yield maximum fresh weight of cut flower and it is epitomized that plant was provided with adequate supply of nutrient and water. A substrate having better physical properties, which influence the absorption of nutrients by the plants which ultimately produced long stems and more turgid flowers thus also increase plants weight at fresh level. The results of dry plant shoot weight were found to be also significant at $p \leq 0.05$ between the growing media used. The findings showed that both microbial media and garden soil had the same reading of dry weight of plants shoot 7g (Table 3). While, the lowest shoot weight was recorded by the Agropolis media at readings of 2g (Table 3).

Pigments content of the rose petal

The anthocyanin content of rose petal determined varies depending on the growing media. Agropolis media has significant content of anthocyanin than other tests which in turn shows no difference insignificantly when compared with the control. Negligible amount of anthocyanin was detected in rose petal grown on garden soil presented in (Fig. 6).

Carotene Content

Carotenoids play pivotal part in the light-harvesting complex and in the photo-protection of the photosystems. The outcomes presented that there were statistically significant differences ($p \leq 0.05$) of petal carotene content among the media used. Garden soil mixed with poultry manure has rose plant with carotenoid content significantly higher than other tests control inclusive. Insignificant differences were observed among the plant grown on Agropolis media, Microbial media and Garden soil respectively. All tests have shown significantly higher

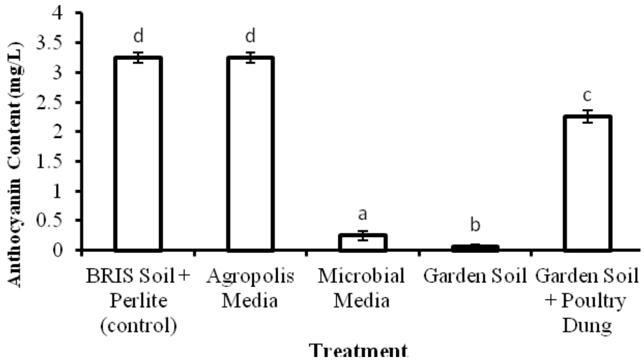


Fig. 6: Effects of growing media on the anthocyanin content of the Rose petal. Bars indicated ± SE. Values with identical letter were statistically significant at $p \leq 0.05$.

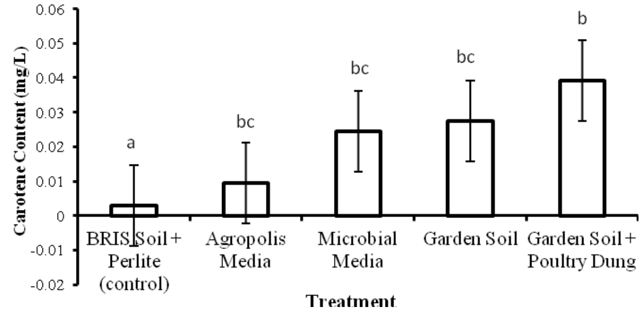


Fig. 7: Growing media impact on carotene content of the leaf of rose. Bars indicate ± SE. Values with common letter were statistically significant difference at $p \leq 0.05$.

content of carotenoid than control (Fig. 7).

The results showed that leaf TSS content have had positive correlation with the number of flower and flower longevity of potted rose plants (Figure 8a). Number of flower and flower longevity enhanced with the increase of leaf TSS content of rose plants under potted condition with different growing media (Fig. 8a and b).

Discussion

Growth media are known to partake crucially in the growth and ornamental plants development (Grigatti *et al.,* 2007; Riaz *et al.,* 2008). Growth media are known with their imperative role in physiological and anatomical parameters of the plant which include germination, height, number of leaves, number of flowers (Ikram *et al.,* 2012). Water holding capacity, aeration and adequate nutrition supply are considered to be the best conditions a growing media should have (Yasmeen *et al.,* 2012). The growing media effects on plant development and growth on potted ornamental plants have been reported to depend on the species type and kind of media used (Castaldi and Melis, 2004). This made use of five different media including the control had substantial effects on the study parameters selected for the growth and development *Rosa hybrida* of Zinnia. The growing media proved to exert no significant effect on the leaves number produced by each treatment. The control treatment was found to produce the highest number of leaves. This results probably from strong ability to retain water in bris soil in combination with perlite treatment, causing decrease in substrate temperature in the pots and vigorous growth of plants increase the flower production. According to Ushio *et al.,* (2008) modest temperature increases the activities of several photosynthetic enzymes, such as Rubisco, stromal fructose-1, 6-bisphosphatase and sucrose-phosphate synthase. Yamori *et al.,* (2005) also conveyed that the quantity of Rubisco increased in spinach leaves grown under low temperature. In addition, Sage and Kubien (2007) have freshly disclosed that plants accustomed to lower temperatures most often demonstrate boosted Rubisco content. No impact of the growing media was observed on growth and development of *Ficus variegata* (Danu *et al.,* 2017). Flowers are known to be fundamental human life part as a results of their miscellany in nature, aesthetic, texture, fragrance, form and color (Ikram *et al.,* 2012). Garden soil in

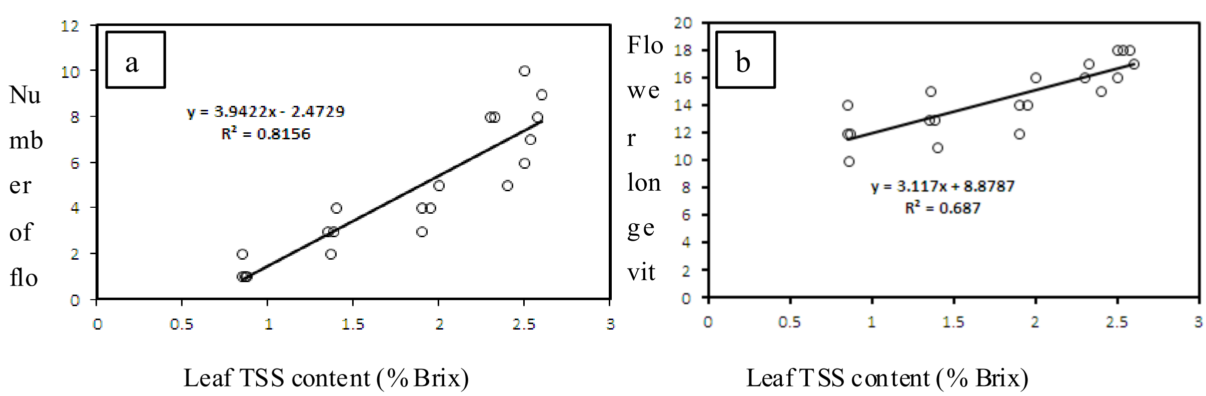


Fig. 8: Correlation between leaf TSS content (%Brix) with number of flower (a) and flower longevity (b) of potted rose plants.

combination with poultry was found to produce highest number of flower as compared to other media used. Similarly, it has been previously reported, the nutritional composition of the media largely contributed to the abundance of the flower on plants (Ikram *et al.,* 2012). Environmental and the soil composition are the factors unto which the number of flower produced and flower growth depends (Cho *et al.,* 2017). Poultry manure was reported to contained high amount of nitrogen that helped in the production of the flower (Alabi, 2006). Content of chlorophyll has been described as a crucial parameter in agronomy (Li *et al.,* 2006). Bris soil with the combination of perlite (control) showed the highest chlorophyll content. Ikram *et al.,* (2012) reported chlorophyll levels in plants in correlation with nitrogen content of the leaves in crop plants, in similar way with photosynthetic capacity and productivity of the plants. Garden soil in combination with poultry manure showed the high percentage of TSS in the Leaf. While bris soil reported the least. The main reason for minimum total soluble solids in bris soil with combination of perlite due to lack of nutritional value of the substrate as the characteristics of the perlite showed no nutrient available in the composition of perlite. Perlite has pH of 7.0–7.5 (neutral), but it has no buffering ability and does not enclose any mineral (Blok and Kaarsemaker, 2011). In particular, soil pH in can be painstakingly taken as fundamental variable due to its impact on numerous other soil proprieties and routes of contributing to plant growth. , most micronutrients are more available in acid soils to plants and generally chores plant growth than in neutral-alkaline soils, (Lonèariæ *et al.,* 2008). According to Jiang *et al.,* (2017) many characteristics of plant are influenced by pH; height, lateral spread, biomass, flower size and number, pollen production, etc. encompasses. Garden soil mixed with poultry manure media has the highest diameter of flower, petal length, number of petal and length root. Ornamental plant with good diameter is normally the best-regarded quality that is more preferred by the consumers for various purposes such as to be used as bedding plants, cut flowers or potted plants (Ade *et al.,* 2015). Increase in size of flower could doubtlessly be due to the increased leaf area which in turn increased activity of Rubisco from leaves to flowers (Ade *et al.,* 2015). Both potting media may contain higher K_2 content, which has good physicochemical properties like high porosity, good water holding capacity and higher retention of moisture which leads to improving the length of petal (Chavada *et al.,* 2017). A good amount of leaves coupled with conducive root environment would led to proper nutrient uptake in the substrates may result in greater accumulation of food matter leading to an increase in root length (Dutt *et al.,* 2002). Dry matter is what remains after all of the water was evaporated out and was an indicator of the number of nutrients that are available to the plant (Richards *et al.,* 2002). Fresh Weight of Root, Dry Weight of Root, and Fresh Weight of Plant were found to have no significant differences among the growth media used for this study. Dry matter content was also an important attribute in plant ecology because they are associated with many critical aspects of plant growth and survival (Yulin *et al.,* 2005). Bris soil in combination with perlite and agropolis media produced high percentage of anthocyanin. Garden soil with poultry manure combination produced high contents of Carotene. Carotene compounds are very important in protecting the photosynthetic apparatus against photo-damage, by interconversions among the xanthophyll apparatus molecules (Latowski *et al.,* 2011).

Conclusion

The growth parameters of *Rosa hybrida* were significantly improved by the mixture of different media used in the study. Media with rich minerals are required for the efficient growth and development of *Rosa hybrida*. Garden soil with addition of poultry manure showed the best growing media for the production of *Rosa hybrida* in terms of the number of flowers, flower longevity, total soluble solids content of leaf, the diameter of flower, the length of petal, the number of petals, the length of root and the anthocyanin content of the rose petal as a results of all the required are readily available in the media. The study recommends the use of garden soil with the combination of poultry manure for potted rose as well as other cut flower production.

Acknowledgement

The authors are thankful to the Center for Research Excellence and Incubation Management (CREIM), Universiti Sultan Zainal Abidin, Terengganu, Malaysia for providing the publication support.

References

Ade, K., D. Lal and A. Mishra (2015). Development and Quality evaluation of Pineapple pomace and Wheat bran fortified biscuits. *The Allahabad Farmer J.,* **70(2):** 110-122.

Alabi, D. (2006). Effects of fertilizer phosphorus and poultry droppings treatments on growth and nutrient components of pepper (*Capsicum annuum* L). *Afr. J. Biotechnol.,* **5(8):** 671-677.

Arnon, D.I. (1949). Copper enzymes in isolated chloroplasts phenoloxidase in *Beta vulgaris*. *Plant Physiol.,* **24:**1.

Baydar, H. (2006). Oil-bearing rose (*Rosa damascena* Mill.) cultivation and rose oil industry in Turkey. *Euro Cosmetics,* **14(6):**13-25.

Blok, C. and R. Kaarsemaker (2011). *Ph in rockwool* *propagation blocks: a method to measure the ph buffer capacity of rockwool and other mineral rooting media.* Paper presented at the International Symposium on Growing Media, Composting and Substrate Analysis, 1013-1023.

Cardellina, J.H. (2002). Challenges and opportunities confronting the botanical dietary supplement industry. *J. Nat. Prod.,* **65(7):** 1073-1084.

Castaldi, P. and P. Melis (2004). Growth and yield characteristics and heavy metal content on tomatoes grown in different growing media. *Com. Soil Sci. Plant Anal.,* **35(1-2):** 85-98.

Chavada, J., B. Thumar, A. Vihol, V. Patel and B. Padhiyar (2017). Effect of Potting Media on Growth, Flower Yield and Quality of Rose (*Rosa hybrida* L.) CV. Top Secret under Protected Condition. *Int. J. Pure App. Biosci.,* **5(5):** 821-827.

Cho, L.H., J. Yoon and G. An (2017). The control of flowering time by environmental factors. *The Plant J.,* **90(4):** 708-719.

Copping, L.G. and J. J. Menn (2000). Biopesticides: a review of their action, applications and efficacy. *Pest Manag. Sci.,* **56(8):** 651-676.

Danu, D., K.P. Putri and D.J. Sudrajat (2017). Effect of Media and Growth Regulators on the Propagation of Nyawai (*Ficus variegata* Blume) Shoot Cutting. *J. Pemuliaan Tanaman Hutan,* **11(1):** 169-177.

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

Grigatti, M., M.E. Giorgioni and C. Ciavatta (2007). Compost-based growing media: Influence on growth and nutrient use of bedding plants. *Biores. Technol.,* **98(18):** 3526-3534.

Guterman, I., M. Shalit, N. Menda, D. Piestun, M. Dafny-Yelin, G. Shalev and M. Emanuel (2002). Rose scent: genomics approach to discovering novel floral fragrance–related genes. *The Plant Cell,* **14(10):** 2325-2338.

Hummer, K.E. and J. Janick (2009). Rosaceae: taxonomy, economic importance, genomics. In *Genetics and genomics of Rosaceae*, 1-17, Springer.

Hussain, A. and M. A. Khan (2016). Short Communication Effect of Growth Regulators on Stem Cutting of *Rosa bourboniana* and *Rosa gruss-an-teplitz. Int. J. Agril. & Biol.,* 1560–8530/2004/06–5–931–932.

Ikram, S., U. Habib and N. Khalid (2012). Effect of different potting media combinations on growth and vase life of tuberose (*Polianthes tuberosa* Linn.). *Pak. J. Agri. Sci.,* **49(2):** 121-125.

Jiang, Y., Y. Li, Q. Zeng, J. Wei and H. Yu (2017). The effect of soil pH on plant growth, leaf chlorophyll fluorescence and mineral element content of two blueberries. *Acta Hort.*, **1180:** 269–276. doi: 10.17660/ActaHortic.2017.1180.36

Khan, M.A., Z. Khurram and A. Iftikhar (2004). Effect of various hormones and different rootstocks on rose propagation. *Pakistan J. Biological Sci.,* **7(10):** 1643-1646.

Khandaker, M.M., S. Rahmat, N. Alias, S.M. Khamsah and N. Mat (2019). The Effects of Different Growing Media on Growth, Flowering and Quality of *Petunia grandiflora*. T*arim Bilimleri Dergisi–J. Agril. Sci.*, **25:** 373-383.

Kiran, M., J. Baloch, K. Waseem and M. Jilani (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 J. Biol. Sci.,* **10(22):** 4140-4143.

Latowski, D., P. Kuczynska and K. Strzalka (2011). Xanthophyll cycle–a mechanism protecting plants against oxidative stress. *Redox Rep.,* **16(2):** 78-90.

Li, R.H., P.G. Guo, B. Michael, G. Stefania and C. Salvatore (2006). Evaluation of chlorophyll content and fluorescence parameters as indicators of drought tolerance in barley. *Agril. Sci. China,* **5(10):** 751-757.

Lonèariæ, Z., K. Karaliæ, B. Popoviæ, D. Rastija and M. Vukobratoviæ (2008). Total and plant available micronutrients in acidic and calcareous soils in Croatia. *Cereal Res. Commun.,* **36:** 331–334. doi: 10.1556/CRC.36

Riaz, A., M. Arshad, A. Younis, A. Raza and M. Hameed (2008). Effects of different growing media on growth and flowering of *Zinnia elegans cv. Blue* Point. *Pak. J. Bot.,* **40(4):** 1579-1585.

Richards, R., G. Rebetzke, A. Condon and A. Van Herwaarden (2002). Breeding opportunities for increasing the efficiency of water use and crop yield in temperate cereals. *Crop Sci.,* **42(1):** 111-121.

Rodriguez-Saona, L.E., M.M. Giusti and R.E. Wrolstad (1999). Color and pigment stability of red radish and red-fleshed potato anthocyanins in juice model systems. *J. Food Sc.*, **64:** 451-456.

Sage, R.F. and D.S. Kubien (2007). The temperature response of C_3 and C_4 photosynthesis. *Plant Cell Environ.*, **30:** 1086–1106.

Stein, G., R. Frost and K.H. Fl (2009). Rosaceae Taxonomy, Economic Importance, en om ics. Doi 10.1007/978-0-387-774 91 -6- 1

Ushio A., T. Mae and A. Makino (2008). Effects of temperature on photosynthesis and plant growth in the assimilation shoots of a rose, *Soil Sci. Plant Nutri.,* **54(2):** 253-258.

Yamori, W., K. Niguchi and I. Terashima (2005). Temperature acclimation of photosynthesis in spinach leaves: analyses of photosynthetic components and temperature dependencies of photosynthetic partial reactions. *Plant Cell Environ.*, **28:** 536–547.

Yasmeen, S., A. Younis, A. Rayit, A. Riaz and S. Shabeer (2012). Effect of different substrates on growth and flowering of *Dianthus caryophyllus cv.'Chauband Mixed'. American-Eurasian J. Agril. Environ. Sci.,* **12(2):** 249-258.

Younis, A. and A. Riaz (2005). Effect of various hormones and different rootstocks on rose propagation. Caderno de Pesquisa série Biologia, **17(1):** 111-118.

Yulin, L., D.A. Johnson, S. Yongzhong, C. Jianyuan and T. Zhang (2005). Specific leaf area and leaf dry matter content of plants growing in sand dunes. *Bot. Bull. Acad. Sin.,* **46:** 127-134.