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# Effect of Different Media on Some Growth, Flowering and Biochemical Parameters of Two Cultivars of Gladiolus (*Gladiolus grandiflorus* L.) under Soilless Conditions

Ali Jabbar[1], Ali Tahranifar[1]*, Mahmood Shuor[1] and Seyyed Hosein Nemati[1]
[1] Department of Horticultural Science and Landscape, Faculty of Agriculture, Ferdowsi University of Mashhad, Iran

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*Corresponding author's email: tehranifar@um.ac.ir

Abstract

This experiment was conducted to study the effect of cocopeat: perlite medium with three ratios (v/v) (1:1, 3:1 and 1:3) on some vegetative, flowering and biochemical parameters of two gladiolus cultivars (Strong and White) under soilless conditions in 2016. Data indicated that most vegetative parameters such as plant height, leaf number and leaf area, flowering parameters such as spike emergence, spike diameter, spike length, and number of florets per spike and biochemical parameters like chlorophyll *a*, chlorophyll *b*, soluble sugars and N, P and K (%) uptake in leaf were significantly affected by cultivars, media and their interactions. As the results showed, there was a significant interaction between cultivars and media for plant height and dry weight of florets where taller plants were obtained from cv. White and cocopeat: perlite at the ratio of 1:3, while higher dry weight of florets were observed in cv. Strong and cocopeat: perlite at the ratio of 1:3. All the studied parameters showed significant increase in the treatment containing cocopeat: perlite at the ratio of 1:3 in both cultivars.

**Keywords:** Cocopeat, Macronutrient uptake, Perlite, Soluble sugars.

## INTRODUCTION

Floriculture has great export potential to develop fast as a sub-sector of agriculture due to its high demand in floral trade worldwide (Anderson *et al.*, 2010). In commercial floriculture, bulbous ornamental crops are an important group of plants and considered as the wealth of the countries. They play an important role in floriculture industry as well as in landscaping and also in terms of the aesthetic value of cut flowers. The bulbous flowers are very popular throughout the world. No gardener would wish to be without bulbous plants. The beauty, fragrance and wide range of colour and form make them the most attractive group among flowers. Gladiolus is a glamorous flower, a flower of perfection, without which no garden will look complete. It is one of the easiest flowers to arrange and ever favourite with flower arrangers, amateurs and experts. Very few flowering plants can match the wide range of colours, shapes and sizes offered by this exquisite bulbous flowering crop (Narendra, 2011). Gladiolus (*Gladiolus grandiflorus* L.) is an all-time favourite for the cut-flower industry as it occupies a leading position among cut flowers due to its elegant appearance and spikes of different hues and its long vase life (Bose *et al.*, 2003; Anderson *et al.*, 2012; Sajjad *et al.*, 2014). One factor that is of great importance to the cultivation of flowers and ornamental plants is medium. Today, soilless substrates used in greenhouses for the production of potted plants and herbs are expanding. These materials usually include a mix of planting beds such as peat moss bark, compost, and a variety of inorganic materials such as perlite, vermiculite, sand and rock wool (Parviz and Ali, 2014). Today, many substances that are used as planting beds, each with its unique characteristics, are in general, composed of these materials with their high water retention capacity to storage water, adequate ventilation, proper drainage, high cation exchange capacity, and the lack any adverse impact on the plants (Javanpour Heravi *et al.*, 2005). Palm peat substrates do not differ significantly with peat moss for the growth of most plants and this implies that the substrate can replace peat\ moss for others substrates such as cocopeat and perlite the results of (Shabani *et al.*, 2011; Hesami *et al.*, 2010; Hematian Dehkordi *et al.*, 2010; Samiee, 2004) are consistent.

In recent years, some problems in soil culture (such as salinity and unsuitable soil characteristics) and limitation of water resources in many countries, especially in Iran, have contributed to the expansion of soilless culture. Soilless culture is an artificial means of providing plants with support and a reservoir for nutrients and water. The use of soil in conservative agriculture is facing many limitations in this country. After many years of cultivation, farmers are now suffering from deteriorated soil fertility and the increase in soil salinity, as well as the increase in soil-borne diseases and limited productivity of crops. Therefore, the use of the substrate-based agriculture is a logical alternative to the current soil-based production approach in the country. Hydroponic scientists have concluded that plants can be grown without using soil if growers provide the plants with nutrients by fertilization and fertigation (Papadopolus, 1994). Little research has been done on bulbous plants in general and gladiolus in particular under soilless conditions. Magnani *et al.* (2003) reported that lapillus was compared to a traditional substrate with perlite and alternative ones with coconut fibre, either single or in a mixture can give excellent productions for the bulbous species tested. Lapillus gave good results with gladiolus, similar to those with traditional perlite, with respect to the qualitative characteristics of the stem (fresh weight and height). Slight decrease in the qualitative characteristics of lily was observed when the lapillus was used singly, whereas it gave very satisfying results when used in a mixture with coconut fibre. Tribulato *et al.* (2003) reported that among substrates, lavic basalt mixed with peat led to higher stem length and thickness and fresh weight of cut flowers. The highest plant density showed slightly lower product quality, thus it seems possible to grow a high number of plants per square meter and increase the yield. Inden and Torres (2004) reported that utilisation of rockwool and perlite in hydroponics culture of tomato results in higher yields as compared to other inert materials. Miller (2008) reported that not all cultivars of tulips were adapted to hydroponics production. Yahya *et al.* (2009) said that

cocopeat was a good growing media component with acceptable pH, electrical conductivity and other chemical attributes, but it was recognized to have high water holding capacity which caused poor air-water relationship, leading to low aeration within the medium, thus affecting the oxygen diffusion to the roots. Paul *et al.* (2010) showed the effects of different hydroponics systems and growing medium components on growth, yield and quality of gladiolus. Grassotti and Gimelli (2011) carried out an experiment to evaluate the influence of various types of cultivation on quality of cut lily flowers, two varieties, 'Cordelia' and 'Narbonne', grown in a closed cycle soilless system. Tehranifar *et al.* (2011) reported the effect of three soilless media on growth and development of two types of *Lilium* The media were 100% cocopeat, 50% gravel + 50% sand and 40% peat + 60% perlite. In general, the media of 50% gravel + 50% sand was similar the two other media in terms of most measured traits.

The main objective of this study was to assess the effect of different ratios of cocopeat and perlite on the studied traits in terms of economic feasibility, since perlite can be produced inside Iran at a low cost and plants can grow faster because they get all the nutrients they need in the proper amounts and proportions by the physical characters of perlite versus cocopeat, which is imported from other countries, making it a costly material. As well, it should be noted that plants grow poorly in cocopeat as compared to perlite.

## MATERIALS AND METHODS

This experiment was conducted at the glasshouse of Department of Horticultural Science and Landscape, Faculty of Agriculture, Ferdowsi University of Mashhad, Iran, in 2016 to study the effect of cocopeat: perlite medium with three ratios (v/v) (1:1, 3:1 and 1:3) on some vegetative, flowering and biochemical parameters of two gladiolus cultivars (Strong and White) under soilless conditions. The corms used in the experiment were purchased from a local commercial centre in Mahallat. The mean size of these corms was 2.5 cm in circumference. The pots were filled by the medium (10 kg/pot) with three ratios (v/v) (1:1, 3:1 and 1:3), and then three healthy corms were planted at the depth of 10 cm. The size of the pots was 25 cm × 40 cm and each pot had an open system of irrigation and nutrition. Plants were irrigated twice a day for 5 minutes (the amount of water was 0.5 L/pot/ day). The composition of the nutrient solution used for 'gladiolus grown in stirred solution culture for 28 weeks, with full strength modified Hoagland's nutrient solution included 210 mg/l nitrogen, 31 mg/l phosphorus, 234 mg/l potassium, 48 mg/l magnesium, 160 mg/l calcium, 64 mg/l sulphur, 2.5 mg/l ferrous, 0.5 mg/l manganese, 0.5 mg/l boron, 0.02 mg/l copper, 0.5 mg/l zinc and 0.02 mg/l molybdenum (Hoagland and Arnon, 1950). The pH and EC of the Hoagland solution were set at 6 and 2 dS/ $m^{-1}$, respectively. The glasshouse day / night temperatures were set at 24/20 °C during the experiment. Relative humidity was adjusted at 50% and the light intensity averaged 90 µmol/$m^2$/$s^{-1}$ during the day. The standard cultural practices were folowed during the entire growing period of the crop.

The experiment was laid out in factorial based on completely randomized design with three replications. The observations related to the different growth, flowering and biochemical parameters were recorded at the end of the experiment. Plant height was calculated by measuring the length from the base of plant to the tip of the florets. Leaf number was measured by counting the leaves. Leaf area ($cm^2$) was determined by a leaf area meter device (AM 100, England). Floret fresh and dry weight per spike were measured on three florets using a digital scale and expressed in gram. Spike emergence was recorded by counting the days from corm planting to spike emergence on three plants in each plot, then they were averaged and expressed in days. Spike length was measured from the end where it was cut off at the base to the tip of the spike. Florets number/spike was recorded by counting the number of florets. Diameter of spike was measured by using slide callipers. Chlorophyll contents were measured according to the method described by Rami and Porath (1980). Total soluble sugars were determined in the methnolic extract by using

the phenol _ sulphuric method according to Dubois *et al.* (1966). Macronutrients N, P and K in the leaves (%) were measured according to Cottenie *et al.*, 1982). Analysis of the data was performed by JMP8 software and means were compared by Duncan's multiple test.

## RESULTS

### Vegetative growth

**Plant height (cm):** The results regarding the height of the plants showed the significant difference between the two cultivars, where higher plant height of 154.73 cm was obtained from cv. White when compared to cv. Strong with the height of 119.86 cm. Among the media, cocopeat: perlite medium at the ratio of 1:3 showed the highest plant height of 143.68 cmwhile cocopeat: perlite medium at the ratio of 3:1 produced the shortest plants with the height of 131.76 cm (Table 1). As the results showed, there was a significant interaction between cultivars and media, so that the highest plant height 160.66 cm was obtained from combined treatment of cv. White and cocopeat: perlite medium at the ratio of 1:3 with in comparison with cv. Strong grown in cocopeat: perlite medium at the ratio of 3:1 that produced the shortest plants with the height of 114.88 cm (Fig. 1).

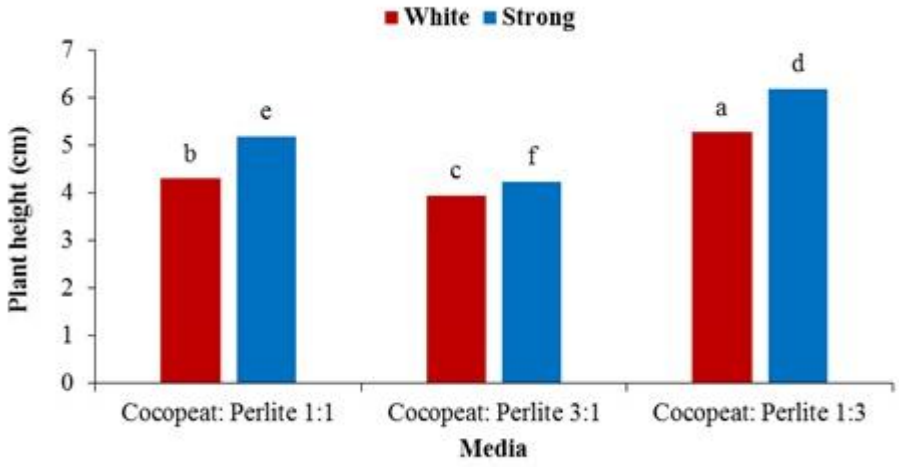


Fig. 1. Interdictions effects of different media and two gladiolus cultivars on height of plant under soilless conditions.

**Number of leaves per plant:** The results for leaf number per plant showed that, significant differences between the two cultivars, where the higher number of leaves per plant (11.70 leaves) were obtained from cv. White, when compared to cv. Strong with (10.36 leaves). Furthermore, in media with different ratios, the highest number of leaves per plant (11.61 leaves) was obtained in cocopeat: perlite medium at the ratio of 1:3, whilst the lowest number of leaves was (10.55 leaves) observed in treatment containing cocopeat: perlite at the ratio of 3:1. In addition, the results showed no significant interaction among cultivars and media (Table 1).

Leaf area: According to the data exhibited in Table 1, the two cultivars showed significant differences in terms of leaf area so that cv. White had higher leaf area of 69.96 $cm^2$ compared to that of cv. Strong 65.25 $cm^2$. Among the media, plants produced in cocopeat: perlite at the ratio of 1:3 had the highest leaf area of 72.11 $cm^2$, while plants in cocopeat: perlite at the ratio of 3:1 showed the lowest leaf area 63.94 $cm^2$.

Table 1. Main effects of different media on height of plant, leaf number and leaf area (cm2) in two gladiolus cultivars under soilless conditions.

| Cultivars | Plant height (cm) | Leaf number | Leaf area ($cm^2$) |
|---|---|---|---|
| Strong | 119.86 b | 10.36 b | 65.25 b |
| White | 154.73 a | 11.70 a | 69.96 a |
| **Media** | | | |
| Cocopeat: perlite (1:1) | 136.44 b | 10.94 b | 66.77 b |
| Cocopeat: perlite (3:1) | 131.76 c | 10.55 c | 63.94 c |
| Cocopeat: perlite (1:3) | 143.68 a | 11.61 a | 72.11 a |

*Similar letters in each column indicate not significant difference at 5% probability level (LSD test).

| Significance levels | | | |
|---|---|---|---|
| Cultivars | ** | * | * |
| Media | * | * | * |
| Cultivars × Media | * | ns | ns |

**, *, ns: Significant at 1% and 5% and non-significant, respectively.

## Flowering parameters

Spike emergence: The results regarding spike emergence showed the significant difference between cultivars, where the lowest number of days to spike emergence (61.20 days) was obtained from cv. White, in comparison to cv. Strong (68.67 days). There was also significant difference between different media in terms of spike emergence, where the number lowest days to spike emergence (63.88 days) was obtained from cocopeat: perlite at the ratio of 1:3, in comparison with cocopeat: perlite at the ratio of 3:1 (65.88 days). There was no significant interaction between cultivar and media for this trait (Table 2).

Table 2. Main effects of different media on spike emergence (days), spike length (cm) and number of florets per spike in two gladiolus cultivars under soilless conditions.

| Cultivars | Spike emergence (days) | Spike length (cm) | Number of florets per spike |
|---|---|---|---|
| Strong | 68.67 b | 50.88 b | 18.32 b |
| White | 61.20 a | 71.16 a | 20.75 a |
| **Media** | | | |
| Cocopeat: perlite (1:1) | 65.04 b | 60.79 b | 19.10 b |
| Cocopeat: perlite (3:1) | 65.88 c | 58.87 c | 16.92 c |
| Cocopeat: perlite (1:3) | 63.88 a | 62.94 a | 22.45 a |

*Similar letters in each column indicate not significant difference at 5% probability level (LSD test).

| Significance levels | | | |
|---|---|---|---|
| Cultivars | ** | ** | * |
| Media | * | * | * |
| Cultivars × Media | ns | ns | ns |

**, *, ns: Significant at 1% and 5% and non-significant, respectively.

**Spike length:** The results showed that in terms of spike length there was a significant difference between the two cultivars. The higher spike length of 71.16 cm was obtained from cv. White as compared to that of cv. Strong 50.88 cm. Furthermore, among media with different ratios,

the highest spike length of 62.94 cm was obtained from cocopeat: perlite medium at the ratio of 1:3 while the lowest spike length of 58.87cm was observed from the treatment containing cocopeat: perlite medium at the ratio of 3:1. No significant interaction was observed between cultivar and media (Table 2).

**Number of florets per spike:** As can be seen in Table 2, there was a significant difference between the two cultivars regarding the number of florets per spike so that cv. White showed higher number of florets per spike (20.75 florets) versus cv. Strong with lower number of florets per spike (18.32 florets). Moreover, with respect to media with different ratios, plants in cocopeat: perlite at the ratio of 1:3 showed the highest number of florets per spike (22.45 florets), while the number of florets per spike in cocopeat: perlite at the ratio of 3:1 was the lowest (16.92 florets).

**Spike diameter:** Data presented in Table 3 showed no significant difference between the two cultivars in terms of the spike diameter. Besides, cocopeat: perlite medium at the ratio of 1:3 produced the highest spike diameter of 9.35 mm compared to cocopeat: perlite medium at the ratio of 3:1 with the lowest spike diameter of 8.54 mm. There was no significant interaction between cultivar and media for spike diameter.

Table 3. Main effects of different media on spike diameter (cm), fresh weight florets (g) and dry weight florets (g) in two gladiolus cultivars under soilless conditions.

| Cultivars | Spike diameter (mm) | Florets fresh weight (g) | Florets dry weight (g) |
|---|---|---|---|
| Strong | 8.90 a | 11.74 a | 5.20 a |
| White | 9.02 a | 10.80 b | 4.51 b |
| **Media** | | | |
| Cocopeat: perlite (1:1) | 9.00 b | 11.31 b | 4.74 b |
| Cocopeat: perlite (3:1) | 8.54 c | 10.63 c | 4.09 c |
| Cocopeat: perlite (1:3) | 9.35 a | 11.86 a | 5.73 a |
| *Similar letters in each column indicate not significant difference at 5% probability level (LSD test). | | | |
| **Significance levels** | | | |
| Cultivars | ns | * | * |
| Media | * | * | * |
| Cultivars × Media | ns | ns | * |

**, *, ns: Significant at 1% and 5% and non-significant, respectively.

**Floret fresh weight:** According to the data presented in Table 3, the two cultivars showed significant differences to one another in terms of floret fresh weight so that cv. Strong had higher floret fresh weight of 11.74 g than cv. White with floret fresh weight of 10.80 g. Furthermore, among the media, plants produced in cocopeat: perlite at the ratio of 1:3 had the highest floret fresh weight of 9.35 g, while plants in cocopeat: perlite at the ratio of 3:1 showed the lowest floret fresh weight of 8.54 g. No significant interaction was observed between cultivar and media.

**Floret dry weight:** According Table 3, the two cultivars showed significant differences to one another in terms of floret dry weight. Cv. Strong had higher floret dry weight of 5.20 g than cv. White with floret dry weight of 4.51 g. Among the media, plants grown in cocopeat: perlite at the ratio of 1:3 had the highest floret dry weight of 5.73 g, while plants in cocopeat: perlite at the ratio of 3:1 showed the lowest floret dry weight of 4.09 g. The results showed that the significant interaction between cultivar and media for floret dry weight (Fig. 2).

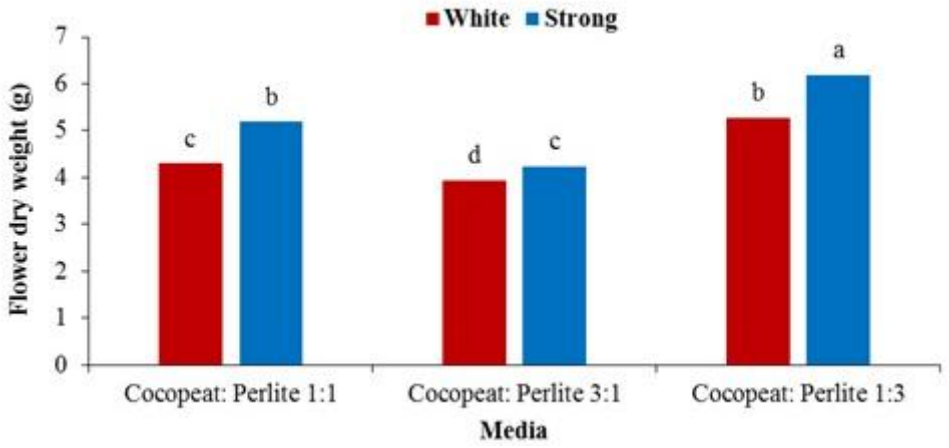


Fig. 2. Interdictions of different media and two gladiolus cultivars for dry weight of flower in soilless conditions.

## Biochemical parameters

**Chlorophyll a content:** The results in Table 4 showed that the two cultivars did not differ significantly in terms of chlorophyll a content. In addition, there were significant differences between different media in this trait so that the highest chlorophyll a content of 0.96 mg/g was obtained from plants grown in cocopeat: perlite at the ratio of 1:3, while the lowest content of 0.80 mg/g was observed from plants grown in cocopeat: perlite at the ratio of 3:1.

Table 4. Main effects of different media on chlorophyll a (mg/g), chlorophyll b (mg/g) and soluble sugars (mg/g) in two gladiolus cultivars under soilless conditions.

| Cultivars | Chlorophyll a (mg/g) | Chlorophyll b (mg/g) | Total soluble sugars (mg/g) |
|---|---|---|---|
| Strong | 0.87 a | 0.62 a | 5.53 a |
| White | 0.90 a | 0.69 b | 6.48 b |
| **Media** | | | |
| Cocopeat: perlite (1:1) | 0.90 b | 0.65 b | 6.00 b |
| Cocopeat: perlite (3:1) | 0.80 c | 0.59 c | 5.68 c |
| Cocopeat: perlite (1:3) | 0.96 a | 0.73 a | 6.35 a |
| *Similar letters in each column indicate not significant difference at 5% probability level (LSD test). | | | |
| **Significance levels** | | | |
| Cultivars | ns | * | * |
| Media | * | * | * |
| Cultivars × Media | ns | ns | ns |

**, *, ns: Significant at 1% and 5% and non-significant, respectively.

**Chlorophyll b content:** Results in Table 4 suggested that chlorophyll b content significantly differed in the two cultivars. Cv. White had higher chlorophyll b content of 0.69 mg/g than cv. Strong with 0.62 mg/g chlorophyll b content. Moreover, among the three medium ratios, plants grown in cocopeat: perlite at the ratio of 1:3 had the highest content of chlorophyll b of 0.73 mg/g compared to the plants grown in cocopeat: perlite at the ratio of 3:1 with the lowest chlorophyll b content 0.59 mg/g.

**Total soluble sugars:** The results in Table 4 showed that the two cultivars significantly differed from one another in terms of total soluble sugar, with cv. White showing higher total

soluble sugars content of 6.48 mg/g than cv. Strong 5.53 mg/g. In addition, the highest total soluble sugars content of 6.35 mg/g was obtained in plants grown in cocopeat: perlite at the ratio of 1:3, while the lowest content of 5.68 mg/g was observed in plants grown in cocopeat: perlite at the ratio of 3:1. No significant interaction was observed between cultivar and medium for this trait.

**Nitrogen content:** The results in Table 5 showed that the two cultivars significantly differed from one another in terms of nitrogen content with with cv. Strong showing higher nitrogen content of 2.65% than cv. White 2.08%. In addition, the highest nitrogen content of 2.64% was obtained from plants grown in cocopeat: perlite at the ratio of 1:3, while the lowest 2.11% was observed from plants grown in cocopeat: perlite at the ratio of 3:1. Besides, no significant interaction was found between cultivar and medium for this trait.

**Phosphorus content:** Results presented in Table 5 suggested that phosphorus content differed in the two cultivars so that cv. Strong had higher phosphorus content0.39% than cv. White 0.31%. Moreover, among the three medium ratios, plants grown in cocopeat: perlite at the ratio of 1:3 had the highest phosphorus content of 0.38% compared to the plants grown in cocopeat: perlite ratio of 3:1 with the lowest phosphorus content 0.26%. Also, no significant interaction was found between cultivars and media for this trait.

**Potassium content:** Regarding potassium content, there was a significant difference between the two cultivars as shown in Table 5. Cv. Strong had higher potassium content of 0.28% than cv. White 0.21%. Furthermore, cocopeat: perlite ratio of 1:3 showed to have the highest potassium content of 0.27 % among all the three medium ratios, while cocopeat: perlite 3:1 showed the lowest potassium content (0.21%). Besides, no significant interaction was found between cultivars and media for potassium content.

Table 5. Main effects of different media on macronutrient uptake nitrogen content, phosphorus content and potassium content (%) in leaf in two gladiolus cultivars under soilless conditions.

| Cultivars | Nitrogen content (%) | Phosphorus content (%) | Potassium content (%) |
|---|---|---|---|
| Strong | 2.65 a | 0.39 a | 0.28 a |
| White | 2.08 b | 0.31 b | 0.21 b |
| **Media** | | | |
| Cocopeat: perlite (1:1) | 2.34 b | 0.33 b | 0.25 b |
| Cocopeat: perlite (3:1) | 2.11 c | 0.26 c | 0.21 c |
| Cocopeat: perlite (1:3) | 2.64 a | 0.39 a | 0.27 a |

*Similar letters in each column indicate not significant difference at 5% probability level (LSD test).

| **Significance levels** | | | |
|---|---|---|---|
| Cultivars | * | * | * |
| Media | * | * | * |
| Cultivars × Media | ns | ns | ns |

**, *, ns: Significant at 1% and 5% and non-significant, respectively.

## DISCUSSION

The observed growth indices show that the highest of the growth plant height and leaf number in place will society medium created will Furthermore great files for every part of plants. Our study agreed with results of many researchers (Shabani *et al.*, 2011; Hamtian Dehkordi *et al.*, 2010). Highest of the leaf area because of their physical, furthermore concoction properties beneficial those best development of plants initiated. Cocopeat also perlite on the wipe properties also

hosting those littlest molecule size, water needs those most astounding sum of force (Noguera *et al.*, 2000). Yet the state doesn't make flooding in the pot on account it may be the property of the slim couch and gradually loses their water. Cocopeat is organic substrates in the composting process that can cause the mineralization of organic matter and change the organic forms of N and P to mineral forms. The available K in organic substrates and perlite related to chemical characteristics of this media is very high (Michael and Heinrich, 2008). Cocopeat has high water holding capacity which creates a poor relationship between air and water, leading to low aeration within the medium which affects oxygen diffusion to the roots.

Perlite-based substrate, which has very low cation exchange capacity (CEC) and good capacity of water absorption, and cocopeat-based substrate, which has high water holding capacity and nutrients can be considered as good growing media in soilless culture and all these factors improve flowering parameters such as spike emergence, spike length, number of florets per spike, and floret fresh and dry weight. These results are agreed with other researcher's e.g. Djedidi *et al.*, 1999; Abad *et al.*, 2002. Simiarly, perlite-based substrates and cocopeat-based substrates can improve biochemical parameters such as chlorophyll *a* content, chlorophyll *b* content and total soluble sugars These results are consistent with other researchers e.g. Djedidi *et al.*, 1999; Abad *et al.*, 2002. Cocopeat and perlite substrates with regard to economic issues, in order to increase moisture storage, can be a good medium for the production's presented country level. Keeping humidity capacity is higher in the medium (Mashadi Jahafarpour and Henareh, 2012). However, about ten times the dry weight is water retention capacity (Khosh Khui *et al.*, 2006). Due to differences in plant growth in different culture media on the cation exchange capacity (CEC), water holding capacity, etc. are attributed to the amount of porosity (Verdonc and Gabriels, 1992).

As discussed, cocopeat and perlite provide adequate nutrients and enhances both physical and biological properties and water holding capacity of media (Soegiman, 1982). A similar result was also reported by (Bhardwaj, 2014). Further, combined application of cocopeat and perlite showed significant effect on vegetative growth parameters and plant biomass probably due to the synergy of these factors improving the physical conditions of the media and nutritional factors (Sahani *et al.*, 2008). These results are akin to the findings of (Bhardwaj, 2014) and (Abirami *et al.*, 2010) who suggested that perlite is low in nutrients and when mixed with cocopeat, it provides a better growth medium for papaya plant establishment. However, the air filled porosity (AFP), easily available water (EAW) and aeration of media.

## CONCLUSION

The results showed that each of the media applied in this study had a strong effect on the improvement of phenotypes and some chemical properties. However, the optimum percentage which is clearly marked is cocopeat: perlite ratio of 1:3. This is very important in reducing production costs and improving gladiolus quality.

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