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RESPONSE OF TWO CULTIVARS OF GLADIOLUS TO DIFFERENT TREATMENTS OF PUTRESCINE, NUTRITION AND MEDIA UNDER SOILLESS CONDITION

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Abstract

This experiment was conducted to study the effects of Hoagland solution, putrescine (50 and 100 ppm), calcium nitrate solution, and coco peat: perlite medium with three ratios (v/v) (1:1, 3:1 and 1:3) on some vegetative and biochemical parameters of two gladiolus cultivars (strong and white) under soilless conditions in 2016. Data indicated that most vegetative parameters expressed as corm sprouting (day), number of corm and number of cormels, and biochemical parameters expressed as soluble sugar (mg/g F.W), phenols (mg/100g F.W) and ascorbic acid (mg/100g F.W) significantly increased. Number of day to corm sprouting, number of corm, number of cormels, soluble sugar, phenols and ascorbic acid in white cultivar were 7.09 days, 1.56, 32.33, 4.87 mg/g, 28.56 mg/100g and 8.36 mg/100g, respectively, and 7.90 days, 1.59, 33.33, 4.58 mg/g, 28.91 mg/100g and 8.13 mg/100g, respectively, in the treatment containing coco peat: perlite medium with ratio (1:3). In contrast, all the parameters studied showed significant increase in the treatment containing Hoagland solution + putrescine 100 ppm (7.46 days, 2.18, 45.00, 6.23 mg/g, 37.01 mg/100g and 11.71 mg/100g, respectively). As the results showed, there was a significant interaction between cultivars and media, media and treatments, cultivars and treatments, and cultivars, media and treatment only regarding corm sprouting.

The results also showed that there was no significant interaction among the factors in terms of other parameters.

Key words:

Calcium nitrate, Gladiolus, Hoagland solution, Putrescine, Soilless

Introduction

Gladiolus is a flower of glamour and perfection which is known as the queen of bulbous flowers because of its flower spikes with florets of massive form, brilliant colours, attractive shapes, varying size and excellent shelf life. Gladiolus stands fourth in the international cut flower trade after carnation, rose and chrysanthemum. Commercial floriculture is one of the most profitable agro industries in the world (Ezhilmathi et al., 2008). Gladiolus (*Gladiolus grandiflorus* L.) is one of the most cultivated, economically important and common flowering plant world-wide including Iran and is among the elite cut flowers due to having different shapes, hues and prolonged vase life (Bose *et al*., 2003). Gladiolus, a member of family Iridaceae and sub-family Ixidaceae, originated from South Africa and is a prominent bulbous cut flower plant.

Production of healthy and vigorous corms and cormels depends on many factors, of which nutrient supply is an important one. Gladiolus requires nutrients throughout the period of growth, corm development, and flowering. So, application of suitable nutrients in an optimum amount is important. Gladiolus cormels responded better to higher doses of fertilizers compared to corms (Mukhopadhaya, 1995).

The growers do not have any recommended doses of chemical fertilizers for quality corm and cormel production. Even the flower producers multiply their seeds without applying any chemical fertilizers. As a result, they are deprived to get optimum sized corms and cormels for flower production. So, there is a good scope of increasing the yield and vigorous corm and cormel production of gladiolus from cormel by the use of appropriate amount of nutrition (F.N. Khan et al., 2002).

Polyamines (PAs) namely putrescine (Put), spermine (Spm) and spermidine (Spd) play important part in different plant developmental processes (Martin, 2001**)**. They modulate several growths and developmental processes such as cell division, differentiation, flowering, fruit ripening, embryogenesis, senescence and rhizogenesis (Kakkar *et al.*, 2000**)**. In all of these processes, PAs have been ascribed various roles such as that of a new class of plant growth regulators, hormonal second messengers and as one of the reserves of carbon and nitrogen at least in cultured tissues (Slocum and Floree, 1991**)**. PAs regulate root development and interaction between microbes and plant roots but this function is not yet well known (Hummel et al., 2002; Walters, 2000; Couee et al., 2004). It is reported that foliar application of PAs increased some nutrients, particularly K uptake, which plays vital role in photosynthesis by directly enhancing the growth and photosynthetic pigments and carbon dioxide absorption (Salama, 1999).

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, causes 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 protected agriculture is facing many limitations in this country. After years of cultivation, deterioration in soil fertility and increase in soil salinity, in addition to the increase of soil-borne diseases and limited productivity of crops, have often been observed. Therefore, utilizing substrate-based agriculture is a logical alternative to the current soil-based production approach in the country. Hydroponic scientists with conducting a lot of examination concluded that plant can grow without using soil if grower supplies plants with nutrient elements by using fertilization and fertigation (Papadopolus, 1994). Dobrzansks (1981) reported that the yield of gladiolus flower was the highest in peat and the lowest yield was found in lignite soil. Leinfelder and Rober (1989) used peat + clay, rockwool, foam, perlite and clay for raising gladiolus. They found that flower quality was similar in peat + clay, rockwool and foam, but quality was very inferior in clay. Sorokina et al. (1984) reported that bark and peat mixture was the best medium for growing ornamental plants. Ahmed (1989) reported that sand + peat and sand + leaf mould enhanced significantly flowering, number of flower and flower size. 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, resulted in the expansion of soilless culture. In the present study, we investigated the effects of different treatments of putrescine, nutrition and media on some flowering parameters and macronutrients uptake in two gladiolus cultivars under soilless conditions.

Materials and methods

This experiment was conducted at the glasshouse of Horticultural Sciences Department, College of Agriculture, Ferdowsi University of Mashhad, Iran, in 2016 to study the effects of Hoagland solution, putrescine (50 and 100 ppm), calcium nitrate solution and two media (coco peat: perlite) with three ratios (v/v) (1:1, 3:1 and 1:3) on some morphological 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 in Tehran (Mahallat). The mean size of these corms was 2.5 cm in circumference. In the present study, two gladiolus cultivars (white and strong), coco peat: perlite medium with three ratios (1:1, 3:1 and 1:3) and 9 treatments including {T_1 control (only water), T_2 Put. 50 ppm, T_3 Put. 100 ppm, T_4 Hoagland solution, T_5 Hoagland solution + Put. 50 ppm, T_6 Hoagland solution + Put. 100 ppm, T_7 Calcium nitrate solution, T_8 Calcium nitrate solution + Put. 50 ppm and T_9 Calcium nitrate solution + Put100 ppm} were investigated. 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 and the space of 30 cm x 20 cm in each pot in May 2016 with an open system of irrigation and nutrition. Plants were irrigated 2 times per day for 5 min. Four weeks after planting, plants were treated with different levels of putrescine. Plants were sprayed with putrescine at the rates of 50 and 100 ppm and sprayed again two weeks before flowering. For better absorption of putrescine, a few drops of twin 20 (Merk) were added to spray solutions. Three healthy corms were planted in one pot. Bed leaching was done weekly to prevent the salt accumulation. The pH and EC of Hoagland solution and calcium nitrate solution were set 6 and 2 dS/ m^{-1}, respectively. The glasshouse day and night temperatures were 24/20°C during the experiment. Relative humidity was adjusted at 50% and the light intensity averaged 90 $mmol/m^2/s^{-1}$. The standard cultural practices were followed 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 vegetative and biochemical parameters were recorded at the end of the experiment. Sprouting corm was accounted from planting to the day of sprouting.

Total soluble sugars were determined in the methnolic extract by using the phenol – sulphuric method according to Dubois *et al*., (1966); total soluble phenols were determined colourimetrically by using Folin Ciocaltea reagent A.O.A.C. (1985); and ascorbic acid concentration of gladiolus was determined by the method suggested by Hans (1992).

Results and discussion

Sprouting corm: The results regarding sprouting corm showed significant difference between cultivars, where the lowest number of day to sprouting corm was obtained in white cultivar (7.09 days) in comparison with strong cultivar (8.89 days). The results regarding sprouting corm showed that there was significant difference between different media, where the lowest day to sprouting corm (7.90 days) was obtained in coco peat: perlite medium with the ratio of (3:1) in comparison with coco peat: perlite medium with the ratio of (1:3) with 8.09 days. Furthermore, the lowest day to sprouting corm (7.46 days) was observed in the treatment containing Hoagland solution + putrescine 100 ppm compared to the control with 8.64 days (Table 1). The results also showed that no significant interactions were found among cultivars and media, media and treatments, and cultivar and treatments. Based on the results, no significant interaction was observed among the three factors of cultivar, medium and treatment (Table 1).

Number of corms: As can be seen in Table (1), there was significant difference between the two cultivars regarding number of corms, so that white cultivar showed higher number of corms (1.56) than strong cultivar with the number of 1.45 corms. The results showed that there was significant difference between different media regarding number of corms, where the highest number of corms (1.59) was obtained in coco peat: perlite medium with the ratio of (3:1), and the lowest number of 1.41 was seen in coco peat: perlite medium with the ratio of (1:3). In addition, Hoagland solution + putrescine 100 ppm resulted in the production of the highest number of corms (2.01) in comparison with control treatment with 1.16 corms (Table 1). The results also showed that no significant interactions were found among cultivars and media, media and treatments, and cultivar, treatments and cultivars (Table 1).

Number of cormels: Data presented in Table 1 showed the significant difference between the two cultivars in terms of number of cormels, where white cultivar showed higher number of cormels (32.33) than strong cultivar with the number of 30.32 cormels. Besides, coco peat:

perlite medium with the ratio of 1:3 produced the highest number of cormels (33.33) compared to coco peat: perlite medium (ratio of 3:1) with the lowest number of cormels (29.35). Compared to the control (water only) with the lowest number of cormels (20.05), application of Hoagland solution + putrescine 100 ppm produced the highest number of cormels (45.00). As the results showed, significant interactions were found between cultivars and media, media and treatments, cultivars and treatments, and cultivars, media and treatments. It was found that white cultivar and coco peat: perlite medium with the ratio of 1:3 showed higher number of cormels (34.33) than strong cultivar and coco peat: perlite medium (ratio of 3:1) with the lowest number of cormels (28.36). Besides, coco peat: perlite medium with the ratio of 1:3 and application of Hoagland solution + putrescine 100 ppm produced the highest number of cormels (47.00) compared to coco peat: perlite medium (ratio of 3:1) and control with the lowest number of cormels (18.16). The results also showed that there was a significant interaction between cultivars and treatments, so that the highest number of cormels (46.00) was obtained in the combination of white cultivar and application of Hoagland solution + putrescine 100 ppm, while combination of strong cultivar and control (only water) exhibited the lowest number of cormels (19.11). Finally, significant interaction effects were found among cultivars, media and treatments, where white cultivar, coco peat: perlite medium with the ratio of 1:3 and application of Hoagland solution + putrescine 100 ppm showed higher number of cormels (48.00) than strong cultivar, coco peat: perlite medium (ratio of 3:1) and control with the lowest number of cormels (17.33). As the results showed, there was a significant difference between the two cultivars in terms of sprouting corm, number of corms and number of cormels which can be due to the genetic traits of the cultivars. These findings confirm the fact that the individual corm characteristics are cultivar specific. Similar and positive responses of plants to soilless culture were reported by several researchers (Seenivasan, 2001 and Paswan, 1985). Coco peat and perlite are 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, which is related to chemical characteristics of this media, is very high (Michael and Heinrich, 2008). Coco peat 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 (Abad *et al*., 2002). Perlite substrate with very low cation exchange capacity (CEC) and good capacity of water absorption, and coco peat substrate with its high water holding capacity and nutrients can be considered as good growing media in soilless culture (Djedidi *et al*., 1999) Application of Hoagland + putrescine 100 ppm resulted in the supply of nutrition required for growth as well as the elongation of the cells, thereby enhancing plant height (Thompsond and Troeh, 1975; Kakkar *et al.*, 2000).

Biochemical parameters:

Total soluble sugars: The results in Table (2) showed that the two cultivars significantly differed from each other in terms of total soluble sugars, with white cultivar showing higher total soluble sugars content (4.87 mg/g) than strong cultivar with 3.89 mg/g. In addition, the highest total soluble sugars content (4.58 mg/g) was obtained in plants grown in coco peat: perlite medium (1:3 ratio), while the lowest content (4.19 mg/g) was observed in plants grown in coco peat: perlite medium with the ratio of 3:1. The results regarding different treatments showed that application of Hoagland solution + putrescine 100 ppm resulted in the highest chlorophyll a content (6.23 mg/g), whereas control (water only) caused the lowest amount of total soluble sugars (2.68 mg/g). The results also showed that no significant interactions were found among cultivars and media, media and treatments, cultivar and treatments, and cultivars, media and treatments (Table 1).

Phenols content: Results presented in Table 2 suggested that phenols content differed in the two cultivars, so that white cultivar with 28.56 mg/100 g had higher phenols content than strong cultivar with 27.46 mg/100 g. Moreover, among the three medium ratios, plants grown in coco peat: perlite (1:3) had the highest content of phenols (28.91 mg/100 g) compared to the plants grown in coco peat: perlite (3:1) with the lowest phenols content of 27.11 mg/100 g. The results also showed that treatment containing application of Hoagland solution + putrescine 100 ppm showed the highest phenols content (37.01 mg/100 g) among all the treatments. The results also showed that no significant interactions were found among cultivars and media, media and treatments, cultivar and treatments, and cultivars, media and treatments (Table 2).

Ascorbic acid content: Regarding ascorbic acid content, there was significant difference between the two cultivars as shown in Table (4); white cultivar with (8.36 mg/100 g) had higher ascorbic acid content in comparison with strong cultivar with (7.35 mg/100 g). Furthermore, coco peat: perlite (1:3) showed the highest ascorbic acid content (8.13 mg/100 g) among all the three medium ratios, while coco peat: perlite (3:1) showed the lowest ascorbic acid content (7.57 mg/100 g). Regarding treatments, the results showed that application of Hoagland solution + putrescine 100 ppm resulted in the highest ascorbic acid content (11.71 mg/100 g) in comparison with control (water only) with the lowest content (4.66 mg/100 g). Besides, no significant interaction effects were found between cultivars and media, media and treatments, cultivars and treatments, and cultivars, media, and treatments (Table 2).

In the present work, the results obtained from the application of nutrition and putrescine are in agreement with the results reported by El-Bassiuony and Bekheta (2001), who obtained increases in the total carbohydrates content in wheat plants treated with putrescine. These increases in total carbohydrates content may be attributed to the increase in the efficiency of photosynthetic process, which led to the increase in net assimilation of leaf CO_2 which is known as the basic unit of carbohydrate. The present data are in agreement with the findings of Youssef and Talaat (2003) on rosemary plants, Abdel Aziz *et al*., (2006) on *Khya senegalensis* plants, Abdel Aziz et al., (2007) on *Syngonium podyphyllum* L. plants, and Farahat *et al.*, (2007) on *Cupressus sempetrirens* L. they found that foliar application of nutrition and putrescine caused an increase in photosynthetic pigments and total soluble sugars content, phenols content and ascorbic acid content.

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Table (1) Main effects of different treatments of putrescine, nutrition and medium on corm sprouting (day), number of corms and number of cormels of two gladiolus cultivars under soilless conditions

Cultivars	**Corm sprouting (day)**	**Number of corms**	**Number of cormels**
Strong	8.89b	1.45b	30.32b
White	7.09a	1.56a	32.33a
Media			
Cocopeat: perlite 1:1	7.98b	1.52a	31.29b
Cocopeat: perlite 3:1	8.09b	1.41c	29.35c
Cocopeat: perlite 1:3	7.90a	1.59a	33.33a
Treatments			
Control	8.64g	1.16cd	20.05i
Put. 50 ppm	8.51fg	1.22cd	22.00h
Put. 100 ppm	8.40ef	1.24cd	23.00g
Hoagland	7.76b	1.88b	41.27c
Hoagland + Put. 50 ppm	7.57ab	2.01b	43.00b
Hoagland + Put. 100 ppm	7.46a	2.18a	45.00a
Nitrate calcium	7.96de	1.27cd	27.00f
Nitrate calcium + Put. 50 ppm	7.90cd	1.27cd	29.33e
Nitrate calcium + Put. 100 ppm	7.72c	1.33c	31.27d
Significance levels:			
Cultivars	**	*	**
Media	*	*	**
Treatments	*	*	**
Cultivars x Media	ns	ns	*
Media x Treatments	ns	ns	*
Cultivars x Treatments	ns	ns	*
Cultivars x Media x Treatments	ns	ns	*

Columns and main effects followed by different letters are significantly different at P<0.05, Duncan's multiple range test. ns: not significant; *, **significant at P<0.05, P<0.01, respectively.

Table (2) Main effects of different treatments of putrescine, nutrition and medium on soluble sugar (mg/g F.W), Phenols (mg/100 g F.W) and ascorbic acid content (mg/100 g F.W) in two gladiolus cultivars under soilless conditions

Cultivars	Soluble sugar (mg/g F.W)	Phenols (mg/100 g F.W)	Ascorbic acid (mg/100 g F.W)
Strong	3.89b	27.46b	7.35b
White	4.87a	28.56a	8.36a
Media			
Cocopeat: perlite 1:1	4.37b	28.00b	7.86b
Cocopeat: perlite 3:1	4.19c	27.11c	7.57c
Cocopeat: perlite 1:3	4.58a	28.91a	8.13a
Treatments			
Control	2.68i	18.81i	4.66fi
Put. 50 ppm	3.15h	20.70h	5.69h
Put. 100 ppm	3.28g	21.57g	5.86g
Hoagland	5.86c	35.21c	9.27c
Hoagland + Put. 50 ppm	6.07b	36.13b	10.49b
Hoagland + Put. 100 ppm	6.23a	37.01a	11.71a
Nitrate calcium	3.87f	26.65f	6.63f
Nitrate calcium + Put. 50 ppm	4.05e	27.55e	7.58e
Nitrate calcium + Put. 100 ppm	4.23d	28.45d	8.78d
Significance levels:			
Cultivars	**	*	*
Media	*	*	*
Treatments	**	**	**
Cultivars x Media	ns	ns	ns
Media x Treatments	ns	ns	ns
Cultivars x Treatments	ns	ns	ns
Cultivars x Media x Treatments	ns	ns	ns

Columns and main effects followed by different letters are significantly different at $P<0.05$, Duncan's multiple range test. ns: not significant; *, **significant at $P<0.05$, $P<0.01$, respectively.