



An abiotic stress factor: Growth substrate effect on *Tulipa gesneriana* growth

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Abstract

Well-known environmental factors for ornamental plants such as biotic or abiotic play a role in plant morphology and changes in flowering time. One of the vital factor is growth media that have an important impact on plant growth and quality of ornamental plants. The present study was carried out to evaluate the effect of different substrates on tulip growth that is one of the flowering-bulbous ornamental plant between December, 2020-July, 2021. Tulip bulbs (*Tulipa gesneriana* L. cv. Pretty Woman) were sown after cold treatment in pots that included two different substrates as peat and perlite under open-field condition to observe plant growth parameters included flower and daughter corm characteristics. Statistical results showed that sprouting week from bulbs and first flower appearance day recorded as earlier in peat (5th week, 111st day) than perlite (7th week, 118th day). Plant height and leaf covered distance also gave better results in peat (34,3 cm; 12,5 cm) than perlite (26,2 cm; 10,9 cm). In all flower characteristics; flower stalk length (26,8 cm in peat; 20 cm in perlite), flower stalk diameter (0,57 cm in peat; 0,53 cm in perlite), flower length (7,5 cm in peat; 6,1 cm in perlite), flower diameter (8,3 cm in peat; 6,3 cm in perlite), considerable flowering rate (95,8% in peat; 79,2% in perlite) and double flowering rate (20,8% in peat; 0% in perlite) were recorded in higher values in peat than perlite. In the other important results; flower longevity and some daughter corm parameters in pots were also statistically more in peat than perlite. According to the data; used substrate has a vital role on plant growth characteristics, plant health and flower longevity of *Tulipa gesneriana* L. cv. Pretty Woman.

Keywords: abiotic factor, tulip, *Tulipa gesneriana* L., peat, perlite, flower longevity, plant growth, daughter bulb

Introduction

Tulip (*Tulipa gesneriana* L.) belongs to the Liliaceae family [1], is a famous, ornamental bulbous plant and is used as cut flower, pot flower and garden plant. Two of the most important issues in flowering ornamental plants are to ensure the longevity of the flower and healthily obtain developing storage organ that will develop the new plant next year. Well-known growth factors such as biotic and abiotic play roles in plant morphology and physiology, directly affecting plant health. One of the vital factor is growth media that have an important impact on plant growth and quality of ornamental plants. Physical, chemical and biological properties of the growth substrates are important environmental factor affecting plant health in agricultural endeavour.

Various growth substrates such as sand, perlite, peat, tree bark, rockwool etc. are used at some stages of propagation and marketing of plants besides mineral soil. These are mentioned in soilless culture as aggregate types [2]. Actually the organic substrates for example peat and non-organic-natural substrates for example perlite [3] can be used alone or mixed in some steps of propagation and marketing of seedlings and saplings of ornamental plants [4-7].

Although it varies among plant species the substrates allow for the simultaneous development of uniform plants, as a result of which all applications can be carried out in a similar way. In addition the substrates can allow uniform application of fertilization programs, aeration of roots and increase water use efficiency [8-10]. Moreover the substrates eliminates the possibility of soil-born pathogen, pests as nematodes or weed seed transmission [11, 12].

On the other hand plant health is not only affected by these pests, diseases and weeds. At the same time environmental

factors threaten plant health both directly and indirectly by making the plant more suitable for the biotic factors by causing nutrients, water and aeration limitations. For this reason, first of all, it should be ensured that the substrate on which the plant is grown is correct and all cultural practices should be done correctly. After being sure of these issues, it may be a permanent and realistic approach to combat the biotic factors encountered.

This study, in which the tulip was chosen as the model plant, was carried out to reveal the differences in plant development and health caused by the substrates, which are used extensively in the plant production and marketing stages, especially in the cultivation of ornamental plants.

Material and Methods

The experiment was conducted at open-field condition of Agriculture Faculty, Kocaeli University, Kocaeli City in Turkey. Hundreds *Tulipa gesneriana* cv. Pretty Woman bulbs were purchased for uniform selection from an agricultural company in October, 2020 (Fig. 1a). The bulbs were exposed to cold storage [13] at $5\pm 2^{\circ}\text{C}$ for forcing the geophyte along one month after purchase. After the storage, the bulbs were remained in the dark cool condition (ca. 14°C) along one month. In December, 17th 2020 the used bulbs were selected to be uniform and the average of important characteristics of all the used bulbs were revealed. Of these features; the circumference was measured 9.74 cm, the diameter as 3.11 cm and the weight as 18.13 g in averages. The peat, agricultural perlite and pots have never used before. The selected square pots are 20 cm in height with a volume of 2 liters. One bulb was sowed to a depth of 8 cm in each pot consisted with peat or perlite alone, on the same day immediately measurements (December, 17th

2020). No application was made except watering in the same amount as needed. The plants were visited every day and noted characteristics in sprouting (Fig. 1b, 1c) and flowering time and duration (Fig. 2a, 2b). Vegetative and flower related characteristics were measured when the each flower fully opened (Fig. 3a, 3b). Daughter bulbs related characteristics (Fig. 4, 5) were measured after the all leaves and stalks completely getting dry in July, 17th 2021. The experiment laid out in Completely Randomized Design (CRD), consisted of 2 treatments and 3 repeats in each treatment. Each repeat had 8 bulbs. Totally the study consisted with 48 sowed bulbs in 48 pots. The recorded data on sprouting, vegetative, flowering and daughter bulbs related were analysed through statistical software for observation the parameter were statically significant or not at 0.05% level.

Results and Discussion

Sprouting Characteristics: The statistically analysis showed that first sprouting week of tulip (5th week in peat, 7th week in perlite), last sprouting week (8th in peat, 11th in perlite) and all sprouting duration (4 weeks in peat, 5 weeks in perlite) significantly affected by growth substrate. Contrary to the data, rate of sprouted bulbs (100% in peat, 95.8% in perlite) and sprouted shoots number (1.72 shoots/bulb in peat 1.23 shoots/bulb in perlite) has not significantly affected by substrates (Table 1). This finding is in line with the results reached by Santos and Castillo^[14], where the mean time of germination of ornamental sunflower seeds statistically affected by used substrates (which were different mixture of charcoal, pine bark, peat, vermiculite and rice hull) and rate of germinated seed showed no differences in the substrates as the study. Contrary to this, Ramzan et al.^[15] had stated that the sprouting rate was 66.73% in control and could be reach maximum 97.76% with bulbs pre-application of 100 mg/L GA₃ to *Tulipa gesneriana* 'Ad-Rem' in their study that hold in leth house with soil. **Vegetative Characteristics:** The data indicates that the plant height (34.3 cm in peat, 26.2 cm in perlite) and distance covered by leaves (12.5 cm in peat, 10.9 cm in perlite) were statistically affected by substrate. But substrates had no effect on leaf number (4.1 leaves/plant in peat, 3.9 leaves/plant in perlite) (Table 2). In a study^[16] on two cultivars of *Lilium* spp. and three medium (100% cocopeat, 50% gravel+50% sand and 40%peat+60%perlite), the number of leaves did not show any differences in medium that supported the data. In the mentioned study^[16] about *Lilium* spp., highest plant height was found in 40% peat+60% perlite medium.

Flowering Time and Duration Characteristics: First day of flower appearance in all repeats begun and ended at 111th day-121st day in peat and 118th-125th day in perlite. In averages, the flower beginning days were found at 116th day in peat and 121st day in perlite. Flower longevity which is very important for an ornamental was found statistically higher in peat (22 days) than perlit (15 days) (Table 3). A similar results were also reported by Jabbar et al.^[17], studied on two cultivar of *Gladiolus grandiflorus* and with three different cocopeat:perlite mixtures (1:1, 3:1 and 1:3 in ratios) and earliness in spike emergence day was found earlier in cocopeat:perlite 1:3 ratio.

Flower Characteristics: All these measured characteristics about flowers were found higher in peat than perlite. In the characters, flower stalk length (26.8 cm in peat, 20.0 cm in perlite), flower length (7.5 cm in peat, 6.1 cm in perlite) and considerable flowering rate (95.8% in peat and 79.2% in perlite) are very important for ornamental plants as known. At the same time according to data, flower stalk diameter, flower diameter and double flowering were also found

statistically higher results in peat (Table 4). A similar results were also reported by Jabbar et al.^[17], studied on two cultivar of *Gladiolus grandiflorus* and with three different cocopeat:perlite mixtures (1:1, 3:1 and 1:3 in ratios) as mentioned above, spike length were found highest in cocopeat:perlite 1:3 ratio.

Daughter Bulbs Characteristics: The daughter bulb numbers per plant (3.85 bulbs/plant in peat, 2.82 bulbs/plant in perlite), all daughter bulbs weight per plant (16.87 g/plant in peat, 11.57 g/plant in perlite) and the biggest daughter bulb weight per plant (8.47 g/plant in peat, 7.16 g/plant in perlite) were significantly influenced by the substrates. The biggest daughter bulb diameter and circumference were also numerically higher in peat than perlite (Table 5). The findings are in line with the report by Maggio et al.^[18], where the peat+perlite media gave higher corm diameter and corm weight results than perlite media in *Crocus sativus* L. **Differences of Newly Forming Main Bulb from Initially Sowing Bulbs:** In the geophyte the biggest bulb has an importance for next year growing and flowering. It is usually believed that the biggest bulb give us more flower and healthy plant. While the peat given better results in main daughter corm, none of the substrates used, achieved reaching out the initial size in bulbs (Table 6).

Conclusion

From the above results and discussion it can be concluded that earliness in bulb sprouting and flowering, plant height, leaves distance, length and diameter of flower and flower stalk are higher in peat than perlite. Although not reaching the initially used dimension, daughter bulb number and the biggest daughter bulb weight resulted higher in peat because of some rot in perlite. Moreover, flower longevity days and considerable flowering rate gave the better results in peat than perlite because of some abortion in perlite. At this condition it is not possible to talk about only plant biotic diseases and pests in cases where the growing environment and other applications are not fully implemented and optimized for a plant in question. The measured parameters gave the messages that the substrate caused abiotic problems that may led biotics if the plant have a disposition for diseases.

Table 1: The sprouting characteristics of *Tulipa gesneriana* cv. Pretty Woman in two different substrates

Sprouting Characteristics	Growth Substrates ^{*,**}	
	Peat	Perlite
First sprouting (week)	5 a	7 b
Last sprouting (week)	8 a	11 b
Duration of sprouting (weeks)	4 a	5 b
Sprouted bulbs (%)	100 n.s.	95,8 n.s.
Sprouted shoots (number/bulb)	1,72 n.s.	1,23 n.s.

*Different lowercase letters within the same line indicate significantly differences between growth substrates at $p \leq 0.05$. **n.s. indicates no significantly differences between growth substrates at $p \leq 0.05$.

Table 2: The vegetative characteristics of *Tulipa gesneriana* cv. Pretty Woman in two different substrates

Vegetative Characteristics	Growth Substrates ^{*,**}	
	Peat	Perlite
Plant height (cm/plant)	34,3 a	26,2 b
Leaf number (number/plant)	4,1 n.s.	3,9 n.s.
Distance covered by leaves (cm/plant)	12,5 a	10,9 b

*Different lowercase letters within the same line indicate significantly differences between growth substrates at $p \leq 0.05$. **n.s. indicates no significantly differences between growth substrates at $p \leq 0.05$.

Table 3: The flowering time and duration characteristics of *Tulipa gesneriana* cv. Pretty Woman in two different substrates

Flowering Time and Duration Characteristics	Growth Substrates ^{*,**}	
	Peat	Perlite
First day of flower appearance (extreme value)	111 a	118 b
Last day of flower appearance (extreme value)	121 a	125 b
Duration of flower appearance (between extreme value)	11 n.s.	8 n.s.
First day of flowering (in average)	116 a	121 b
End of flowering period (in average)	137 a	135 b
Flower longevity day (in average)	22 a	15 b

*Different lowercase letters within the same line indicate significantly differences between growth substrates at $p \leq 0.05$, **n.s. indicates no significantly differences between growth substrates at $p \leq 0.05$

Table 4: Flower characteristics of *Tulipa gesneriana* cv. Pretty Woman in two different substrates

Flower Characteristics	Growth Substrates [*]	
	Peat	Perlite
Flower stalk length (cm/stalk)	26,8 a	20,0 b
Flower stalk diameter (cm/stalk)	0,57 a	0,53 b
Flower length (cm/flower)	7,5 a	6,1 b
Flower diameter (cm/flower)	8,3 a	6,3 b
Double flowering (%)	20,8 a	0 b
Considerable flowering (%)	95,8 a	79,2 b

*Different lowercase letters within the same line indicate significantly differences between growth substrates at $p \leq 0.05$

Table 5: Daughter bulbs characteristics of *Tulipa gesneriana* cv. Pretty Woman in two different substrates

Daughter Bulbs Characteristics	Growth Substrates ^{*,**}	
	Peat	Perlite
Daughter bulb number (number/plant)	3,85 a	2,82 b
Daughter bulb weight (g/plant)	16,87 a	11,57 b
The biggest daughter bulb weight (g/bulb)	8,47 a	7,16 b
The biggest daughter bulb diameter (cm/bulb)	2,52 n.s.	2,37 n.s.
The biggest daughter corm circumference (cm/bulb)	7,91 n.s.	7,24 n.s.

* Different lowercase letters within the same line indicate significantly differences between growth substrates at $p \leq 0.05$, **n.s. indicates no significantly differences between growth substrates at $p \leq 0.05$

Table 6: The new biggest daughter bulb difference from initially sowed bulb of *Tulipa gesneriana* cv. Pretty Woman

New Biggest Bulb Differences Rate from Initial Bulb	Growth Substrates	
	Peat	Perlite
Diameter	18,97 % less	23,79% less
Circumference	19,20% less	26,05% less
Weight	53,28% less	60,50% less



Fig 1: *Tulipa gesneriana* cv. Pretty Woman; a) Initial bulb samples, b) First sprouting in peat at 5th week, c) First sprouting in perlite at 7th week



Fig 2: *Tulipa gesneriana* cv. Pretty Woman; a) First flowering criterion, b) End of flower life criterion in the study



Fig 3: Growth in *Tulipa gesneriana* cv. Pretty Woman at first repeat; a) 18 weeks (126th day) after sowing b) 19 weeks (133rd day) after sowing (left two line in peat, right two line perlite in both of two figures)

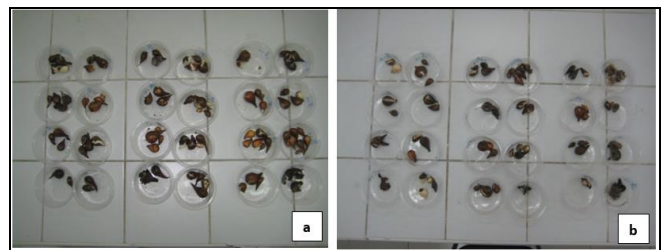


Fig 4: Bulb removing in *Tulipa gesneriana* cv. Pretty Woman 7 months (212nd day) after sowing; a) From peat, b) From perlite

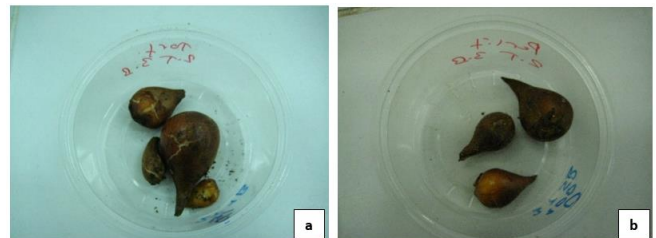


Fig 5: Samples of daughter bulbs per plant in *Tulipa gesneriana* cv. Pretty Woman 7 months (212nd day) after sowing; a) From peat, b) From perlite

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