



ORIGINAL ARTICLE

Effect of Various Planting Substrates on Morphological and Chlorophyll Traits of Narcissus Plant

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ABSTRACT: The studied substrates included soil, soil + leaf mold, soil + cocopeat, soil + perlite, and soil + vermicompost arranged in a Randomized Complete Block Design with three replications. The results showed that the highest germination speed (18) was related to soil and that the highest flower fresh weight (9.25) and flower diameter (52.3) were related to soil + perlite. Substrates did not impact floret number, root length, and flowering time significantly. The highest flower longevity (7 days) was observed in soil + leaf mold. Results of analysis of variance did not display the significant influence on stem length, root length, floret number, leaf number and chlorophyll and flowering time. The results showed that the addition of materials such as vermicompost to soil could improve the important traits of Narcissus flower, including flower life, germination rate and stem diameter, thus reducing the use of chemicals.

INTRODUCTION

Narcissus tazetta L. is a bulbous plant from Amaryllidaceae family. It is widely used in open air as a cut flower, pot flower, or ornamental plant. *Narcissus tazetta* species is among the most important species of Narcissus with flat flower cover and semi-circular flower crown. It flowers from mid-autumn until early-winter [1].

The survival of the plants depends on optimum environmental factors including suitable growing media. Presently, several soilless substrates are used to grow seedling, to propagate the plants, and to produce ornamental plants [2, 3]. The elements of the soilless compounds should bear stable physical and chemical features during the plants' cultivation [4]. In total, an optimum growing media should be capable of supplying high water retention capacity, appropriate drainage, and high cation exchange capacity [5].

The flowers' quality and growth are influenced by a lot of factors, one of the most important ones being the substrate. It is always tried to use substrates that are, in addition to ensuring the flower quality and growth, economic and harmless to water and soil [6]. The impact of planting medium is well-established on the quality of the ornamental plants. It plays a crucial role in germination rate and other physiological parameters like plant height, leaf number and florets per spike, spike length, and crop yield [7]. An optimum growth medium should supply good aeration (air exchange), water retention capacity, and adequate nutrients. When integrated into soilless substrates, some fertilizers perform well in providing the plants with nutrients [8]. Vermicompost is a biological organic fertilizer that is produced by continuous flow of decomposing organic matter through the alimentary tract of certain species of

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earthworm and their expulsion from their bodies [9, 10]. Various studies have stressed out the importance of vermicompost in agriculture and the growing of garden and horticultural plants.

Darzi *et al.* (2008) reported that the application of vermicompost improved the growth characteristics of fennel [11]. The integration of cocopeat into cockscomb substrate showed that 100% and 70% cocopeat with two other organic matters increased plant height, canopy diameter, and leaf number as compared to 40% cocopeat [12].

Ahmad (1989) found that the mixture of leaf mold, garden soil and sand improved the flowering and flower number of roses [2]. The highest plant highest and leaf number in *Dieffenbachias* was observed in plants planted in leaf mold [13]. Sreerama *et al.* (1999) reported that root length of the chrysanthemum cuttings was significantly higher in cocopeat than in other substrates (sand or soil) [14]. In a study on different growth media for the propagation of bulb scales of liliium, it was found that the number of bulblets per scale and mean diameter and weight of bulblets were significantly higher in vermiculite than in other treatments (Kapoor *et al.*, 2000) [15].

Chlorophylls are the most important light absorbing pigments in the thylakoid membrane of chloroplasts. These green pigments have a multi-ring structure similar to that of protoporphyrin in hemoglobin. With the difference that in the center of them there is Mg instead of Fe. Chloroplasts always have both chlorophyll b, a. Both of these chlorophylls are green to complement each other's optical absorption in the visible area. In addition to chlorophylls, the TiLC membrane contains secondary light absorption pigments, namely carotenoids. The most important of these compounds is carotene, which is a red-orange isoprine. Carotenoids absorb light at wavelengths not absorbed by chlorophylls. Therefore, the optical receiver is complementary. The addition of various culture media to soil resulted in improved chlorophyll rose [2]. Most flower producers use garden soil in the production and propagation of the flowers. Given the importance of planting substrates to the quality and yield of the plants, this study explores the effect of various planting substrates on morphological and physiological traits of *Narcissus*.

MATERIALS AND METHODS

The impact of various substrates on morphological and physiological traits of *Narcissus* was investigated in the research greenhouse of Gorgan University of Agricultural Science and Natural Resources in Gogran, Iran as a pot experiment on the basis of a Randomized Complete Block Design with three replications and five treatments in autumn 2016. The substrates included conventional (garden) soil, garden soil + leaf mold, soil + cocopeat, soil + perlite, and soil + vermicompost. Uniform bulbs of *Narcissus* were selected and disinfected with Mancozeb 2:1000 for 30 minutes. Then, they were planted in pots with 20-cm mouth. The recorded traits included germination speed, flower longevity, stem diameter, stem length, root length, floret number, leaf number, root fresh weight, flower fresh weight, flower diameter, root dry weight, flower dry weight, chlorophyll *a* and *b*, total chlorophyll, and flowering time.

Germination speed of the bulbs was calculated by the following equation [16]:

$$GS = \sum_{i=1}^n \frac{S_i}{D_i}$$

where, *GS* denotes germination speed, *S_i* denotes the number of germinated bulbs in each count, *D_i* denotes days to *n*th count, and *n* denotes the frequency of counts. The longevity was specified by visual signs, i.e. when the petals displayed the first signs of turgor loss and wilting. These signs were recorded on a daily basis [17].

The stem and root lengths were measured with a precise ruler, the stem and flower diameters were measured with a digital caliper.

To determine the fresh weight, the samples were weighed with a digital scale. Then, they were oven-dried at 80°C for 48 hours to find their dry weight.

Chlorophyll *a*, chlorophyll *b*, total chlorophyll, and carotenoid contents of the leaves were estimated by Barnes *et al.* (1992)'s procedure [18]. First, 0.5 g of the leaf sample was weighed and ground before pouring into a test tube. Then, 10 ml dimethyl sulfoxide was added and the samples were placed in an oven at 75-80°C for three hours. One ml of the solution was poured into another test tube and was adjusted to 5 ml by the addition

of DMSO. Finally, their absorptions were read at 645 and 663 nm with a spectrophotometer.

$$Chlo\ a\ (mg/g.F.W) = 12.7(A_{663}) - 2.69(A_{645}) * V / 1000 * W$$

$$Chlo\ b\ (mg/g.F.W) = 22.9(A_{645}) - 4.68(A_{663}) * V / 1000 * W$$

$$Chlo\ total\ (mg/g.F.W) = 20.2(A_{645}) +$$

$$8.02(A_{663}) * V / 1000 * W$$

WA = wavelength; V = final volume

of the solution; FW = fresh weight of sample

Data were analyzed with the SAS software package and the means were compared by LSD test.

RESULTS AND DISCUSSION

Germination speed

According to the results of analysis of variance, substrates significantly influenced germination speed of Narcissus bulbs at the 5% probability level (Table 1; $p \leq 5$). Also, means comparison revealed that the highest

germination speed was related to garden soil (18) and the lowest one was obtained from garden soil + cocopeat (Table 2).

The uniform germination and emergence of seeds in some species require optimum level of such factors as the relationship between substrate amount, available water, thermal parameters and the absence of physical barriers. These factors would supply the bulbs with the optimum conditions for germination and emergence. Dias *et al.* (2008) stated that the substrate mixture should be selected in terms of the species characteristics [19]. In a study on the emergence time of *Physalis alkekengi* seedlings in diverse substrates, it was observed that cocopeat was more appropriate than peat for their germination [20]. Unlike our findings, Heydari and Asghari (2010) found cocopeat as the most optimum substrate for the germination of *Moringa olifera* [21].

Table 1. Effect of different substrates on the physiological and morphological characteristics of Narcissus.

S.O.V	DF	Germination speed	Flower longevity	Stem diameter	Stem length	Root length	Floret number	Leaf number	Flowering time
Treatment	4	10.5*	2.16**	12.52*	138.12 ^{ns}	47.9 ^{ns}	2.1 ^{ns}	2.56 ^{ns}	3.9 ^{ns}
Cv (%)	-	9.68	7.73	22.71	23.9	27.65	23.87	21.9	2.82

*, **, ns: Respectively, a significant difference in the level of 5% and 1%, and no significant difference

Flower longevity

Analysis of variance (ANOVA) showed that flower longevity was significantly influenced by substrate (Table 1; $p \leq 1$). Also, means comparison of normal data showed that garden soil + leaf mold and garden soil + vermicompost resulted in the longest flower longevity of 7 days (Table 2).

Flower longevity or, indeed, flower quality preservation is a major determinant of flower marketability.

Mohammadi Torkashvand and Seyedi (2015) examined perlite and cocopeat as the substrate for liliium. They reported that plants treated with cocopeat exhibited longer longevity than those treated with perlite, but those grown in a mixture of perlite and cocopeat had longer longevity.

Table 2. Mean comparison the effect of different substrates on the physiological and morphological characteristics of Narcissus.

Treatment	Germination speed	Flower longevity	stem diameter	Root fresh weight	Root dry weight	Flower fresh weight	Flower Diameter
Soil	18 ^a	6.67 ^{ab}	7.23 ^b	9.73 ^b	1.21 ^{bc}	8.11 ^{ab}	38.4 ^{bc}
Soil + Leaf mold	16 ^a	7 ^a	6.57 ^b	4.17 ^c	0.87 ^c	5.92 ^c	31.09 ^c
Soil+ Coco peat	13 ^b	5 ^c	5.76 ^b	17.82 ^a	1.81 ^a	7.14 ^{bc}	41.53 ^{abc}
Soil + Perlite	16 ^a	6 ^a	6.89 ^b	11.02 ^b	1.29 ^b	9.25 ^a	52.38 ^a
Soil + Vermicompost	17 ^a	7 ^a	11.01 ^a	13.34 ^b	1.74 ^a	8.27 ^{ab}	46.44 ^{ab}

In each column, means with the similar letters are not significantly different at 5% and 1% level of probability using LSD test.

Stem diameter

Substrate changed stem diameter significantly at the 5% probability level as analysis of variance indicated (Table 1; $p \leq 5$). Means comparison of normal data showed that the highest stem diameter was developed in garden soil + vermicompost and the lowest one in garden soil + cocopeat (Table 2).

Stem diameter is a main factor of flower quality. In a study on the impact of various substrates on marigold, Falakboland (2014) reported that vermicompost improved stem diameter significantly, but leaf mold had no impact on it as we came to the same result [22]. Shahbazi *et al.* (2012) showed that vermicompost treatment reduced and perlite treatment increased stem diameter of carnation [6].

Mahboob Khomami (2008) reported that foliar application of drainage of worm substrate improved the plant height, dry weight and fresh weight of aglaonema and Dieffenbachia significantly [9]. N and P content of vermicompost is usually 5-11 times as great as that of soil and it has higher amounts of trace elements and macronutrients than conventional soil and releases them gradually [23]. These elements in vermicompost help the plants grow better, one of whose consequences is higher stem diameters.

Stem length, root length, floret number, leaf number and flowering time

Results of analysis of variance did not display the significant influence on stem length, root length, floret number, leaf number, and flowering time (Table 1).

Root fresh and dry weight

According to analysis of variance, the impact of substrate was found to be significant on root fresh and dry weight at the 1% probability level (Table 3; $p \leq 1$). Also, means comparison of normal data revealed that the highest root fresh and dry weights were obtained from garden soil + cocopeat and the lowest ones from garden soil + leaf mold (Table 2).

Ornamental plants are propagated and grown in diverse substrates [24]. Organic fertilizers help plant growth and biomass production by enhancing available nutrients and their gradual release [25]. Given better vegetative growth in vermicompost treatment and higher shoot fresh and dry weight, root dry weight could be expected to increase too. Accordingly, root dry weight was observed to be higher in this treatment than in control. However, cocopeat was not significantly effective. Pritam and Garg (2010) reported higher root biomass of marigolds treated with vermicompost [26].

There are reports about better growth and yield of marigold, cabbage, fuchsia, henna, gerbera, begonia, and primrose in cocopeat than in peat [27]. Rezaei *et al.* (2013) showed that the addition of cocopeat to peat in rose substrate increased root fresh weight by favorably influencing plant growth parameters [28]. Also, Samiei *et al.* (2005) stated that cocopeat improved root fresh weight of aglaonema as compared to peat moss [29]. Our results are consistent with Rezaei *et al.* (2013) and De Kreij and Van Leeuwen (2001) [28, 27].

Table 3. Effect of different substrates on the Chlorophyll and morphological characteristics of Narcissus.

S.O.V	DF	Root fresh weight	Root dry weight	Flower fresh weight	Flower dry weight	Flower diameter	Chlorophyll a	Chlorophyll b	Total chlorophyll
Treatment	4	75.11**	0.45**	4.78*	0.05 ^{ns}	194.54*	0.005 ^{ns}	0.002 ^{ns}	0.01 ^{ns}
cv	-	19.26	14.68	13.58	13.8	16.1	8.98	19.07	8.94

*, **, ns:—a significant difference in the level of 5% and 1%, and no significant difference, Respectively,

Flower fresh and dry weight

Analysis of variance (ANOVA) showed that substrate influenced flower fresh weight significantly at the 5%

probability level ($p \leq 5$), whilst it had no significant impact on flower dry weight (Table 3). According to means comparison of normal data, the highest and lowest

flower fresh weights were related to garden soil + perlite and garden soil + leaf mold, respectively (Table 2).

With respect to the influence of substrates on flower fresh weight, Amjazi and Hamidpour (2012) reported that vermicompost improved flower fresh weight, but zeolite decreased it [30]. The favorable effect of vermicompost on the growth of the plants is associated with higher water retention capacity, nutrients supply, and plant hormones production induced by this fertilizer [31]. Eskandari *et al.* (2016) found that the use of vermicompost in the substrate of roses enhanced stem and flower fresh weight [32]. Similarly, Ghorbani Moghaddam *et al.* (2014) stated that vermicompost improved shoot fresh weight of marigold [33].

Flower diameter

As analysis of variance indicated, the impact of substrate was significant on flower diameter at the 5% probability level (Table 3; $p \leq 5$). Also, means comparison of normal data revealed that the highest flower diameter was related to garden soil + perlite and the lowest one to garden soil + leaf mold (Table 2).

Flower diameter is an important trait in the assessment of visual quality and marketability of some flowering plants and cut flowers. In a study on the use of perlite + garden soil as the substrate of marigold, Rezaei *et al.* (2010) reported that the substrate improved flower diameter significantly, which is consistent with our findings [34]. Also, Salehi Sardoei and Shahdadnejad (2015) stated that cocopeat + loam soil did not change flower diameter of zinnia [35].

In addition to the improvement of soil physical characteristics such as increasing its moisture retention capacity, vermicompost is effective on coloring and producing larger flowers and ornamental plants and on intensifying the plant odor and essence [36, 23].

Chlorophyll a and b and total chlorophyll

No significant differences were observed in chlorophyll *a* and *b* and total chlorophyll according to the results of analysis of variance (Table 3).

CONCLUSIONS

The results showed that plants grown in garden soil + perlite had higher flower diameter than those in other substrates. Perlite creates porosity in soil, supplying the plants with adequate space for growth and root aeration. Then, it improves the uptake of water and nutrients, resulting in higher photosynthesis and carbohydrate amount. The highest stem diameter was observed in garden soil + vermicompost. Vermicompost influences the physiological and morphological traits of the plants since it supplies the nutrients and has plant hormones. According to the results, it is recommended to mix the soil with such substrates as vermicompost or perlite in order to produce flowers with the highest quality.

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The authors declare that there is no conflict of interests.

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