Journal of Ornamental Plants
Available online on: www.jornamental.iaurasht.ac.ir
ISSN (Print): 2251-6433 ISSN (Online): 2251-6441
Research Paper

Investigating Growth of *Frankenia thymifolia* as a Cover Plant During Drought Stress in Different Growth Media and Irrigation Periods

Mohsen Majidi[1], Ali Mohammadi Torkashvand[2*] and Raheleh Ebrahimi[3]
[1]M.Sc. Student, Department of Horticulture, Science and Research Branch, Islamic Azad University, Tehran, Iran
[2]Associate Professor, Department of Soil Science, Science and Research Branch, Islamic Azad University, Tehran, Iran
[3]Assistant Professor, Department of Horticulture, Science and Research Branch, Islamic Azad University, Tehran, Iran

Received: 12 March 2019 Accepted: 01 July 2019
*Corresponding author's email: m.torkashvand54@yahoo.com

Abstract

There are some plants can replace grass among cover plants. Cover plants are obvious solution of problem in these places that the most important plant is *Frankinia* and *Lisimakia* etc. The aim of this study is to use organic wastes, biological fertilizers and moisture super absorbents in the growth media of *Frankinia* to increase water holding capacity, delay in permanent wilting point and drought stress control. The experiment was carried out during drought stress out of greenhouse in open space in 2017. A factorial experiment based on Randomized Completely Block Design with two factors was conducted. First factor was three periods of irrigation in 2 and 4 days and one week, second factor was different growth media including: 1.90% soil+10% manue, 2. 70% soil, 15% manure+ 15% vermicompost, 3.70% soil, 15% manure+ 15% vermicompost + 1 g/kg stockosorb (super absorbent), 4.50% soil, 25% manure+ 25% vermicompost and 5. 50% soil, 25% manure+ 25% vermicompost + 1 g/kg super absorbent. Rooted transplants of *Frankinia* in pots (diameter 12 cm and height 15 cm) were planted in boxes 30×30 cm numbered 6 every box. Morphological traits including longest branch, total number of lateral branches, dry and fresh weight of shoot, prolin, leaf relative water and the concentration of K, P, Fe and Zn in shoot and uptake of these nutrients by shoot, were measured. The growth media were analyzed for pH, EC, organic carbon, total nitrogen, C/N ratio and P and K available. Results showed the mixture 50-50 of soil and organic compounds (composted manure and vermicompost) is used as the growth medium. Using one g/kg superabsorbent in cited medium in compared with control medium (irrigation period 2 days), can increase irrigation period to one week.

Keywords: Compost, Drought, Growth medium, *Frankinia*, Manure.

INTRODUCTION

The development of urban green spaces faces a number of challenges. Supply of water needed for irrigation and green spaces development in metropolis is considered as one of the most important concerns of water organizations and municipalities, due to the high water consumption by these organizations in the urban environment, and their demand will increase significantly in the coming decades. As the demand for drinking water increases, governments have to restrict the use of fresh water to irrigate urban green spaces (Fallahian, 2006). Green spaces are considered as the vital arteries of cities environmentally. Creating green spaces as the most important cities' environmental moderators is essential due to the increasing urbanization. Green space plays a determining role in supporting urban social and ecological systems (Barbosa *et al*., 2007).

Recently, especially in countries with arid and semi- arid climate, due to water scarcity with proper quality, the expansion and creating new green spaces have faced with serious restrictions. Therefore, selecting drought tolerant species with low water requirements is considered as a solution to resolve the problem of water scarcity (Samiyani *et al*., 2014). Drought as one of the important environmental stresses threatens the production of agricultural products in particular in arid and semi-arid areas. Drought is one of the most important environmental stresses that restricts cultivation of agricultural products by reducing the water content of the plant, reducing the leaf water potential and losing turgor and closure of the stomata, increasing the respiration and consumption of carbohydrates produced by photosynthesis. In spite of this, the plant's reaction to drought stress is completely different, and depends on the intensity and duration of stress as well as species and plant growth stage (Nayyar and Gupta, 2006).

In contrast to drought stress, plants have different protection mechanisms, such as accumulation of osmolites such as proline and soluble sugars in coping with drought stress (Nayyar, 2003).

Drought stress increases the soluble carbohydrates in the cell by decomposing polysaccharides such as starch, (Mohammadkhani and Heidari, 2008). The closure of stomata in response to stress is a mechanism for reducing water loss from plant tissues (Paranychianakis and Chartzoulakis, 2005; Tardieu, 2005), but if this continues for a long time, the rate of photosynthesis is significantly reduced due to decreased stabilization of the carbon dioxide (Tardieu, 2005). Reduced photosynthesis is associated with reducing plant growth. Stress decreases longitudinal growth, and this has direct relationship with water potential. Growth occurs only in conditions of water availability and water potential preservation. Under moisture stress conditions, the number of leaf and leaf area is reduced and the plant has to perform osmoregulation to maintain its moisture conditions. For this, it uses its metabolic energy to produce intermediate substances or accumulate solutes that may cause toxicity to the plant. Also, studies conducted on this field show that moisture stress reduces stem length (Stocker, 1960).

Samiyani *et al*. (2014) investigated the effect of drought stress on some biochemical indices in four cover crop species (turf grass (*Lolium prenne*), *Potentilla reptans*, *Trifolium repens* and *Frankinia*) with the ability to use in the green space. Water scarcity treatments were in four levels (25, 50, 75 and 100% water requirement of grass). Frankinia species had the highest levels of proline and the lowest chlorophyll content. The use of irrigation scarcity treatment regulated to the extent of damages to the plant is an important management solution to reduce water consumption in green spaces.

Easton and Kleindorfer (2009) investigated the effects of salinity levels and seed mass on germination in various species of Australian *Frankinia*. Species with larger seeds at higher salinity levels had higher germination percentage and rate. The treatment of high levels of salinity did not have a negative effect on seed germination. Finally, various species of *Frankinia* are suitable for growth in saline areas.

Rahimi Mohammad Abad *et al.* (2010) investigated a suitable growth medium for producing grass in Gorgan region. The effect of four growth media of sand, soil, rice hulls and spent mushroom compost (SMC) with different ratios on some quality grass traits. According to the results, the quality score, growth rate and chlorophyll content in substrates containing spent mushroom compost (SMC) were significantly higher than substrates containing rice hulls.

MATERIALS AND METHODS

This experiment was performed to investigate the growth of *Frankinia* under drought stress conditions in 2017 outside the greenhouse and in the open environment. Performing all stages of planting, transferring and maintaining the pots containing the plant under experiment in a private greenhouse located on the old road of Karaj.

First, they began to procure supplies and materials:

270 bushes of *Frankinia* in a pot (12 in size);

45 plastic boxes (plot) in dimensions of 30 × 30 cm for planting plants;

Providing appropriate agricultural soil to the extent required and grinding the soil;

Supply of manure and grinding it;

Supply of vermicompost and grinding it;

Supply of the moisture absorbent substance with the brand name of stocozorb and its full saturation by adding water.

The plant materials used in this project included a *Frankinia* rooted plant from the Frankiniaceae family, which consisted of 45 plots planted in each 6 bushes. The number of plants planted in each plot was selected equally and completely randomly.

Experimental design and treatments

A factorial experiment was designed and performed based on a Randomized Complete Block Design with two factors.

Factor I: Three irrigation periods of 2, 4 and 7 days;

Factor II: Five growth media containing different percentages of the ingredients which are listed below:

Growth medium No. 1: containing 90% of soil + 10% manure;

Growth medium No. 2: containing 70% soil + 15% manure + 15% vermicompost;

Growth medium No. 3: containing 70% of soil + 15% manure + 15% vermicompost + 1 g/kg super absorbent;

Growth medium No. 4: containing 50% soil + 25% manure + 25% vermicompost;

Growth medium No. 5: containing 50% soil + 25% manure + 25% vermicompost + 1 g/Kg of superabsorbent.

Plant cultivation and maintenance

The *Frankinia* seedlings were rooted in pots with an opening diameter of 12 and a height of 15 cm, and were planted in rectangular plots in dimensions of 30 × 30 cm, so that 6 seedlings were planted in each plot. However, the walls of the plots used completely and the floor of the plots was covered by plastic layers so that excess water can be removed from the root environment. 45 plots were prepared from each treatment, 3, 3 replicates and in 5 different substrates. After the growth period, the following traits were measured:

Morphological traits including the length of the longest branch, as well as the total number of lateral branches produced;

Plant harvesting and evaluation of wet and dry weight of aerial parts and plants root;

Investigating the leaf's relative water content.

Chemical properties of cultivating substrates

The Kjeldahl method was used with the Kjel-Tec technique was used in order to measure total nitrogen in the substrate (Goos, 1995). The method provided by Page *et al*. (1982) was used in order to measure phosphorus in substrate. Verdonck and Gabriels (1992) method was used to measure pH and EC in substrate. According to this method, in order to measure pH in the substrates, 400 cubic meters of substrate was mixed in a volume of 1 to 5 (i.e., 1 part of the substrate to 5 parts of distilled water) in Erlenmeyer Flask. The pH was measured by the pH meter of the El-metron and EC models by the Jenway machine. Walky and Black method (Page *et al*., 1982) was used in order to measure organic carbon.

Measurement of elements in plant aerial parts

In order to extract the nutrients in the aerial parts (shoot), 0.3 g of dried specimen in oven was transferred to a 50 ml volumetric flask with a special weighing funnel. Then 2.3 ml of the mixture of acids (sulfuric acid and salicylic acid) was added and shaken carefully to make it wet. The mixture was cooled overnight and the next day the specimen was heated to 180 °C for one hour and after cooling, 5 drops of hydrogen peroxide water were added and the volumetric flasks were placed on the oven and the temperature increased to 280 °C until evaporated water and white vapor appeared. This continued until the specimen became colorless. Then the specimens were removed from the oven and after cooling, 10 ml of water was added and shaken to dissolve most of the sediment, then the water added to it to reach the desired volume and finally it was filtered after shaking (Emami, 1996).

The extract prepared was used to measure leaf'scalcium, magnesium, iron and manganese content using an atomic absorption device (Emami, 1996). The extract was used for potassium measurement and was measured by flame photometr, the jenway model (Emami, 1996). Morphy and Rayleigh method (Goos, 1995) was used to measure plant phosphorus. The total nitrogen of the plant was measured using the titration method after distillation by Kjeldahl method (Goos, 1995). A volume of 5 ml of extract was prepared and transferred to a distillation flask and 2 ml of sodium hydroxide solution was added to it, then the distillation was performed in optimum time.

The experiment was performed in a Randomized Complete Block Design (RCBD) with 6 treatments in 3 replicates and 3 plants in each treatment. MSTATC software and Least Significant Difference test were used in order to evaluate the results of data on chemical analysis of leaf and the growth factors of *Dracaena*. The corresponding charts were plotted using Excel.

RESULTS AND DISCUSSION

Chemical properties of growth media

Table 1, shows the chemical properties of the growth media used containing nitrogen, phosphorus, iron and zinc, organic carbon, acidity, carbon to nitrogen ratios and electrical conductivity. In general, the nitrogen content increased as organic matter content in the growth medium was increased. The highest nitrogen content (0.54%) was found in growth medium 5 (containing 50% organic matter including manure and vermicompost) and the lowest nitrogen content (0.16%) was related to the control substrate. The lowest phosphorus content was related to the control substrate (33 mg/kg) and the highest phosphorus content (135 mg/kg) was observed in growth medium 5.

It is necessary to consider the chemical properties of the growth medium, as they have a significant effect on the quality of the plant. Chemical properties directly have a significant effect on the ability to dissolve food and maintain it (Robert and Browder, 2005). In hydroponics, the element content in the nutrient solution varies according to the amount of absorption of the plant and the amount of its requirement (Bialczyk *et al*., 2007). The C/N ratio in growth media was

Table 1. The chemical characteristics of substrates used in experiment.

Growth medium*	Nitrogen (%)	P (mg/kg)	Fe (mg/kg)	Zn (mg/kg)	OM (%)	C/N Ratio	pH (1:5)	EC (ds m^{-1}) (1:5)
1	0.16	33	8.77	2.24	2.89	18.0	7.91	1.00
2	0.38	75	20.85	5.30	6.25	16.4	7.21	1.40
3	0.30	81	31.19	8.11	5.17	17.2	8.08	1.90
4	0.51	78	20.75	14.00	8.47	16.6	7.63	2.32
5	0.54	135	30.96	11.57	9.07	14.1	7.63	2.21

1. Growth medium No. 1: containing 90% of soil + 10% manure;
2. Growth medium No. 2: containing 70% soil + 15% manure + 15% vermicompost;
3. Growth medium No. 3: containing 70% of soil + 15% manure + 15% vermicompost + 1 g/kg super absorbent;
4. Growth medium No. 4: containing 50% soil + 25% manure + 25% vermicompost;
5. Growth medium No. 5: containing 50% soil + 25% manure + 25% vermicompost + 1 g per kilogram of superabsorbent.

lower than allowable limit (C/N=30) which is suitable for ornamental plant growth. Davidson *et al*. (1994) reported that composts with a C/N ratio of less than 20 are ideal for producing the plants. Higher value of C/N ratio was observed in the control treatment due to low content of nitrogen in the growth medium. The C/N ratio in the growth media decreased with increasing the volume of compost, which was consistent with Gayasinghe *et al*. (2010).

Some of the most important factors to determine the salinity level for ornamental plants includes plant size and appearance. The highest EC was observed for the substrate containing 50% compost and manure and the lowest EC was related to the control substrate. The amount of EC in the growth medium was higher than the proper limit for ornamental plants (1-3 dS/m). Grigatti *et al.* (2007) during a study concluded that with adding green waste compost in proportions of 25, 50, 75 and 100 (volume percent) in the replacement with peat in the ornamental plant' growth medium, pH and EC increased.

Analysis of variance of data on the effect of treatments

According to tables 2 and 3 on data analysis of variance, the effect of treatments on plant growth indices was significant. The same significant effect has been observed on plant growth traits due to irrigation time and interaction of treatment in time. The effect of treatments, irrigation time and interaction of treatments on percentage of leaf relative water content (% RWC) was not significant at 5% level.

Effect of growth medium treatments on growth and nutrient status of plant nutrients

The effect of growth medium treatments on the growth traits of the *Frankinia* is shown in Figs. 1 to 4. A clear trend is observed in plant growth, so that from growth media 1 to 5, plant growth has increased. Precision in the composition of substrates indicates an increase in organic matter and a decrease in the amount of mineral soil in the substrate. Considering the growth rate of the plant, the best growth medium was 5, in which plant growth significantly was more than others. In this treatment, 50% of the growth medium includes organic materials that contains one gram of superabsorbent per kilogram of substrate. Dry weight in treatments 2-5 was increased compared to control due to increasing organic matter and providing appropriate amounts of nutrients in the soil and on the other hand improving water holding capacity and improving physical properties of soil (Almasiyan *et al*., 2006). Moldes *et al*. (2007) during a study concluded that urban waste compost could provide all the high-consumption nutrients for plant growth and thereby improve plant yield.

Table 2. The results of ANOVA related to the effect of growth medium and irrigation on the growth traits of plant.

SoV	df	MS				
		Lateral branches number	Longest branch	Shoot fresh weight	Shoot dry weight	RWC of leaf
Block	2	7.37*	26.6**	2287.0*	119.0**	4.0 ^{ns}
Treatment (Growth medium)	4	2175.6**	1474.4**	139354**	11048**	187.9 ^{ns}
Time (Irrigation)	2	188.2**	165.7**	28208.7**	1249.4*	43.6 ^{ns}
Time × Treatment	8	12.7**	12.4**	5967.2**	1247.3**	127.0 ^{ns}
Error	28	2.12	0.78	458.7	332.3	114.2
CV (%)	-	14.2	10.3	17.5	8.7	21.4

*, ** and ^{ns}: Significant at P<0.05, P<0.01 and insignificant, respectively.

Table 3. The results of ANOVA related to the effect of growth medium and irrigation on the nutrients concentration and uptake by shoot of plant.

SoV	df	MS							
		Concentration				Uptake			
		P	K	Fe	Zn	P	K	Fe	Zn
Block	2	0.83 ^{ns}	0.57 ^{ns}	1.25 ^{ns}	0.41 ^{ns}	4.0 ^{ns}	0.53^{ns}	1.07^{ns}	0.008^{ns}
Treatment (Growth medium)	4	4.62*	2.1 ^{ns}	3431**	7.2*	7.2*	20.7**	155**	2.3**
Time (Irrigation)	2	1.25 ^{ns}	0.15 ^{ns}	604.9^{ns}	0.68 ^{ns}	0.68 ^{ns}	3.95^{ns}	30.5*	0.08^{ns}
Time × Treatment	8	3.57*	3.3*	1110**	5.6*	5.6*	6.0^{ns}	40.3**	0.21^{ns}
Error	28	1.45	1.54	279.7	2.54	2.54	3.58	8.4	0.06
CV (%)	-	34.4	23.7	31.3	20.7	20.7	27.6	22.6	31.5

*, ** and ^{ns}: Significant at P<0.05, P<0.01 and insignificant, respectively.

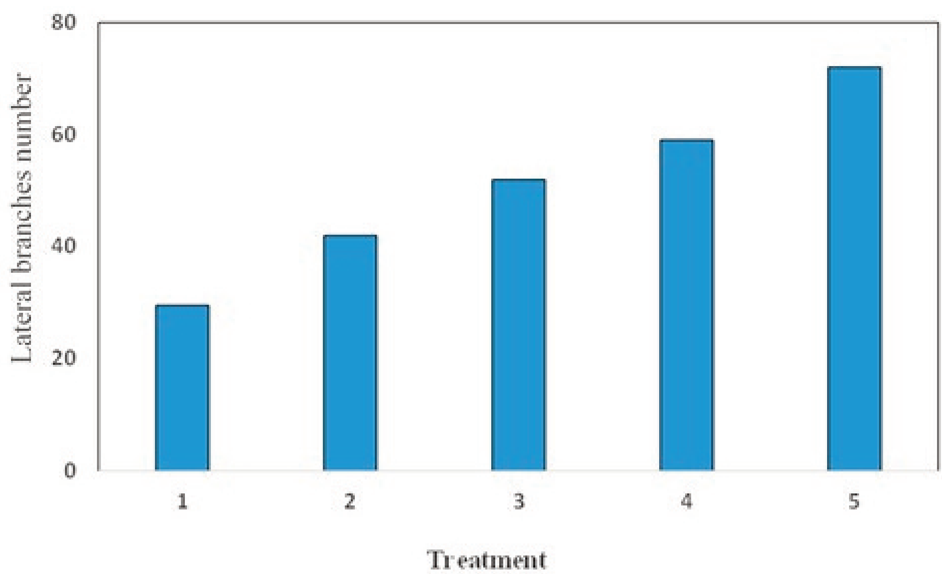

Fig. 1. Effect of treatment on the lateral branches of *Frankinia*.

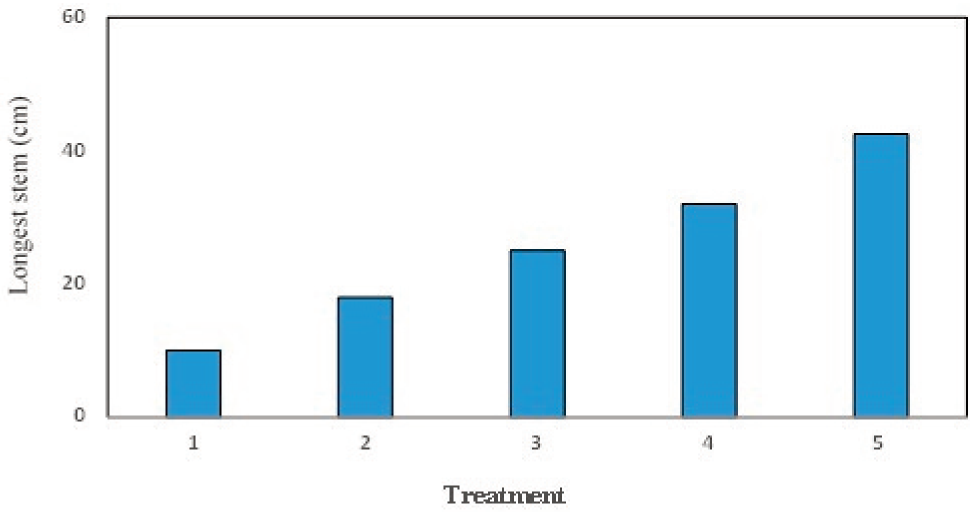

Fig. 2. Effect of treatment on the longest stem of *Frankinia*.

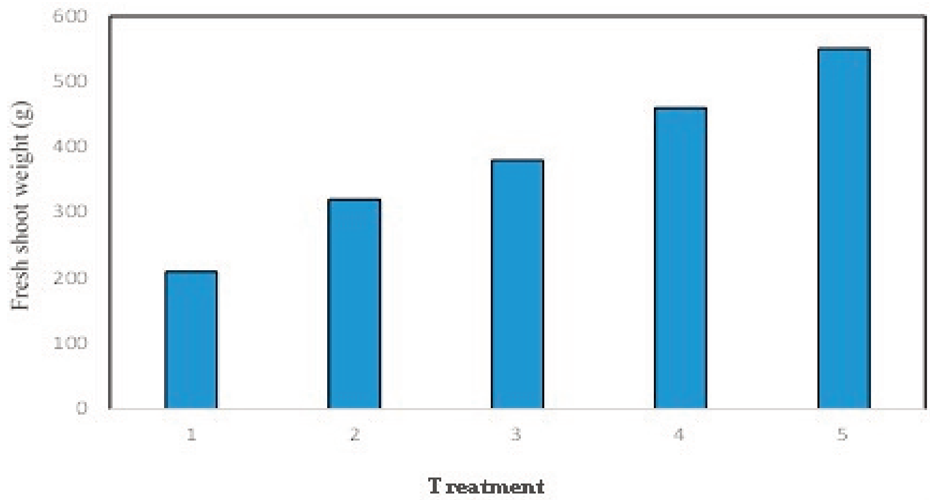

Fig. 3. Effect of treatment on the fresh shoot weight in *Frankinia*.

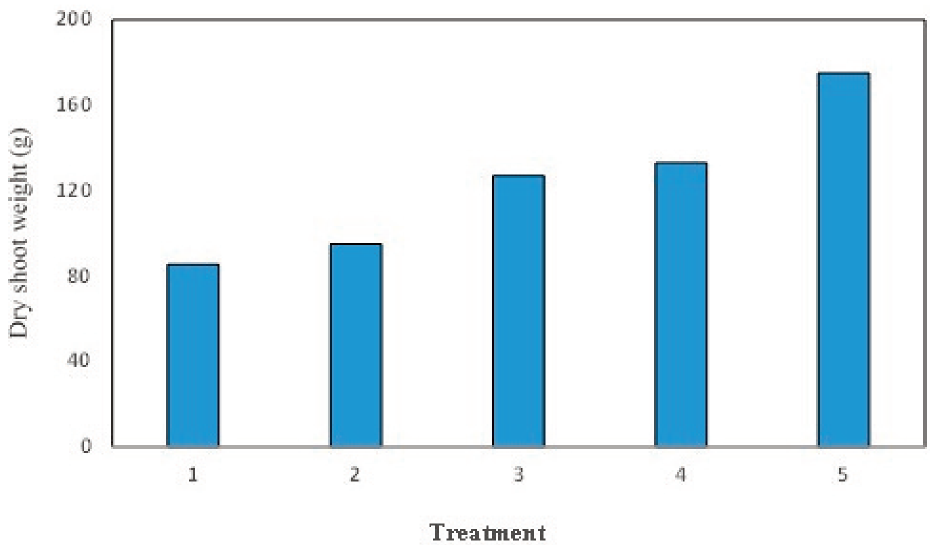

Fig. 4. Effect of treatment on the dry shoot weight in *Frankinia*.

Due to the presence of superabsorbent in the growth medium, treatments 3 could be better than treatment 2 and treatment 5 better than 4. The effect of growth medium treatments on the Percentage of leaf relative water content (% RWC) at the harvesting stage is shown in Figs. 5 and, leaf water status in treatment 3 is better than other treatments. Sivapalan (2001) during a greenhouse experiment investigated the effect of aqueous adsorbent polymer called aquasorb application on the performance and efficiency of soybean's water consumption in a sandy soil. Soybean water use efficiency was increased by 12 times in 0.03% by weight of superabsorbent and 19 times in 0.07% compared with control treatment.

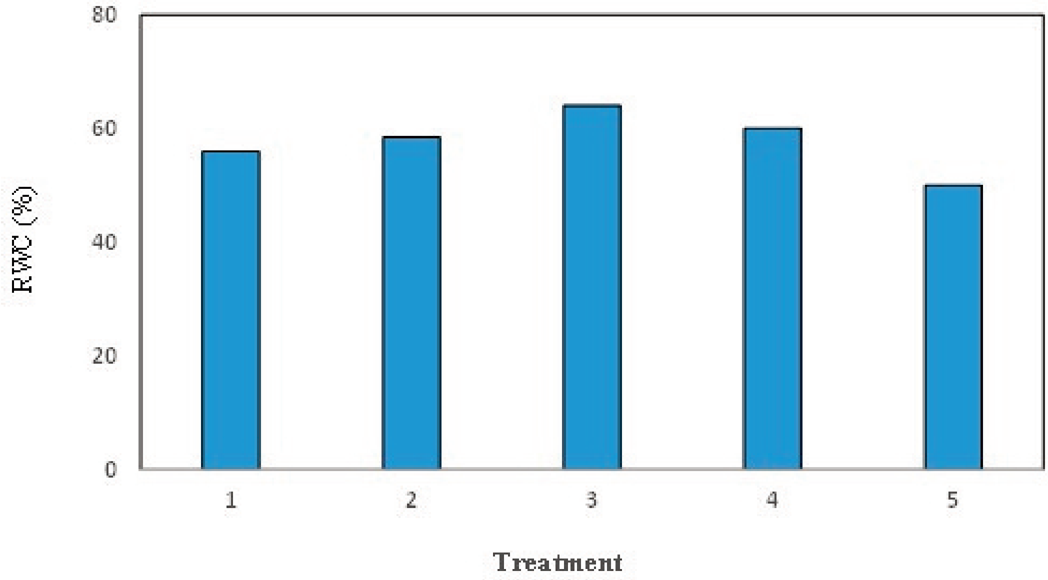

Fig. 5. Effect of treatment on the leaf RWC in *Frankinia*.

Plant growth, especially height, increased due to improved physical properties of the growth medium and increased essential nutrients affecting plant growth including nitrogen, phosphorus, iron and zinc. Shadanpur *et al*. (2011), during a study added vermicompost to the growth medium containing peat-perlite and concluded that plant growth indices, especially size and weight of parsley, were significantly increased in compared with control growth medium (peat-perlite). Jankauskien and Brazaity (2008) used a combination of perlite, vermiculite and coconut tree fiber with the peat substrate, and investigated its effect on growth and development of tomato, they concluded that seedlings planted in peat- vermiculite and peat-perlite growth medium, had higher root weight, stem diameter and leaf area.

Mohammadi Torkashvand *et al*. (2015) investigated the effect of manure on *Strelitzia reginae* and concluded that the highest growth rate was obtained by increasing the compost content up to 45%. Mohammadi Torkashvand *et al.* (2015), during a study concluded that *Azolla* compost combining with other organic matter in the growth medium has significant effect on the growth of English daisy.

Effect of irrigation time on growth and status of plant food elements

The effect of irrigation time on growth and concentration of nutrients in the aerial parts and the amount of nutrient uptake by the *Frankinia* aerial parts is listed in table 4. In general, according to the results, plant growth at 2 days of irrigation was significantly better than 4 days and one week. This is due to the favorable water supply for plant growth. Mohammadi Torkashvand *et al.*

(2016) reported similar results in investigating the effects of irrigation and growth medium on *Lysimachia* growth, so that they concluded that increasing irrigation leads to decrease the growth of the plant. Obviously, increasing irrigation time and drought and subsequent drought stress can lead to reduce plant growth and growth indices. Of course, the amount of reduced growth and the tolerance limit depends on the objectives of the work and the amount of available water, which is sometimes more important than plant growth, because in the water crisis, the minimum issues have a higher significance. A significant increase in the percentage of leaf relative water content (% RWC) during a week compared to four days and a week can't be reliable alone, unless it is measured in different periods, secondly, due to water consumption efficiency by the plant, it is associated with drought and reduced transpiration in the leaves with closure of the stomata. Under moisture stress, percentage of leaf relative water content (% RWC) reduces and some changes are made in its aqueous interactions before ion changes (Munns and Jame, 2003). Also, according to the studies, moisture stress reduces the length of the stem (Stocker, 1960), which is consistent with these results. The length of the longest stem was significantly reduced by increasing the irrigation duration from 2 days to one week.

Table 4. The effect of irrigation period on the growth of *Frankinia*.

Irrigation period **Trait**	**2 days**	**4 days**	**One week**
Lateral branches number	53.4 a	49.5 b	46.4 c
Longest branch (cm)	29.0 a	26.2 b	22.4 c
Shoot fresh weight (G)	427.7 a	379.0 b	341.2 c
Shoot dry weight (G)	131.2 a	122.4 ab	113.0 c
RWC of leaf (%)	56.4 a	58.2 a	59.8 a

*In each column, means with the similar letter(s) are not significantly different ($P < 0.05$) using the LSD test.

Interaction of growth medium and irrigation duration treatments on growth and nutrient status of plant nutrients

According to the results listed in table 5, the substrate containing organic matter leads to increase growth compared to the control significantly. Control substrate contains 90% soil and 10% organic matter, but the results shows that if the substrate contains 50% organic matter and 1 g kg^{-1} of superabsorbent with one-week irrigation, plant growth is even higher than the control with 2-day irrigation and this is the main point of the present study.

The interaction of growth medium and time treatments on the status of nutrients is shown in table 6. It should be noted that the concentration of nutrients in plant tissues is not considered as a reliable index, because several factors have significant effect on the mobility and accumulation of nutrients inside the plant, such as the effect of dilution in a tissue with a deficiency of a nutrient, the concentration of the nutrient mentioned is higher than the optimum level (Mohammadi Torkashvand, 2006). It is better to use the nutrient uptake index instead of the concentration of nutrients in this field. Because there is a significant relationship between the concentration and the yield and dry weight of the plant, therefore the effect of dilution is lost and is a more favorable index with regard to plant yield. But in this study, both concentration and nutrients uptake indices as qualitative indices did not represent the treatments, and the main criterion is the quantitative indices of plant growth.

Table 5. The interaction effect of irrigation period and growth medium on the growth of *Frankinia*.

Irrigation intervals (day)	Growth medium	Lateral branches number	Longest branch (cm)	Shoot fresh weight (g)	Shoot dry weight (g)	Leaf RWC (%)
2	1	36.0f	12.6 g	374.6 hi	90.8 f	58.8 a
	2	44.0 e	21.0 e	342.3 f	77.1 g	56.1 a
	3	52.0 c	28.0 cd	387.3 d	147.5 bc	59.6 a
	4	61.0 b	34.0 bc	470.0 bc	126.0 cd	58.5 a
	5	74.3 a	49.5 a	664.3 a	214.7 a	48.9 a
4	1	29.0 g	8.5 h	252.6 i	91.2 s	57.6 a
	2	41.0 e	19.5 ef	322.3 g	108.9 e	50.6 a
	3	50.5 cd	27.0 cd	370.0 de	115.9 d	60.5 a
	4	59.0 bc	32.6 c	460.0 c	130.0 c	63.7 a
	5	68.0 ab	43.5 ab	490.0 b	166.0 b	58.4 a
7 (One week)	1	23.0 h	7.0 h	135.0 j	75.5 g	53.9 a
	2	38.5 ef	16.0 f	294.0 h	95.6 f	68.8 a
	3	49.0 d	23.0 e	362.3 e	115.5 d	71.3 a
	4	54.0 c	30.0 c	432.3 cd	136.5 c	58.1 a
	5	67.5 ab	36.0 b	482.5 b	141.7 bc	46.8 a

*In each column, means with the similar letter(s) are not significantly different (P <0.05) using the LSD test.

Table 6. Interaction effect of duration irrigation and growth medium on nutrient statuses in *Frankinia*.

Irrigation intervals (day)	Growth medium	Nutrient in shoot				Nutrient uptake from medium (mg/pot)			
		P (%)	K (%)	Fe (mg/kg)	Zn (mg/kg)	P	K	Fe	Zn
2	1	2.37 de	6.11 b	133.0 b	12.0 b	2.18	5.57	12.08 c	1.10
	2	3.37 cd	6.37 ab	95.5 e	8.9 e	2.25	4.91	7.09 d	0.72
	3	2.80 d	6.03 b	79.5 f	8.4 e	4.11	8.97	11.75 c	1.25
	4	1.68 g	6.36 ab	84.5 f	9.8 c	2.12	8.02	10.59 c	1.23
	5	2.46 de	3.60 f	122.0 c	11.8 b	5.14	7.72	26.16 a	2.55
4	1	5.67 a	5.95 b	95.5 e	9.4 d	5.29	5.47	8.61 d	0.86
	2	3.69 c	5.48 c	101.0 d	11.3 b	3.96	6.06	11.06 c	1.21
	3	2.35 de	4.10 e	84.5 f	7.8 e	2.66	4.68	9.71 d	0.91
	4	1.93 ef	6.56 a	71.0 g	10.8 c	2.47	8.48	9.32 d	1.41
	5	1.88 f	6.57 a	100.0 d	10.4 c	3.11	10.87	16.60 b	1.72
7 (one week)	1	2.68 d	5.00 d	149.0 a	10.4 c	2.08	3.72	11.96 c	0.78
	2	3.20 cd	6.75 a	72.0 g	9.3 d	3.08	6.36	6.91 e	0.89
	3	1.44 h	5.51 c	62.5 g	9.2 d	1.65	6.34	7.27 a	1.06
	4	2.26 e	5.23 cd	110.0 d	10.5 c	3.05	7.14	15.05 b	1.43
	5	4.03 b	5.20 cd	99.5 d	15.2 a	5.77 a	7.38	14.13 b	2.16

*In each column, means with the similar letter(s) are not significantly different (P <0.05) using the LSD test.

Therefore, if the aim is to plant a grass as alternative and specifically *Frankinia* as a cover plant in arid and water scarcity conditions, it would be possible to increase the irrigation duration by changing the growth medium like no. 5, and not only no problems will be created in terms of water scarcity, but plant growth and yield indices, including the number of branches created, their dispersion and plant weight will be increased significantly.

Superabsorbent polymers by delaying the moisture stress in plants and providing a buffering mode against loss of crop over time between two irrigation periods can increase water holding capacity (Mohammadi Torkashvand *et al*., 2017). Drought stress reduces the length of the stem and leads to dwarfism (Stocker, 1960). Polymers will prevent this phenomenon by reducing the effect of drought stress.

CONCLUSION

In general, according to the results, the irrigation and plant growth program can be changed by changing the common growth medium in urban green space, which, unfortunately, is obtained with the soil mixture and the amount of manure without scientific examination. The fundamental conclusion can be listed as follows.

Application of a mixture of manure and vermicompost with soil in the *Frankinia* growth medium;

50-50 mixture of organic matter and soil;

Using 1 g kg^{-1} from synthetic superabsorbents;

Using this growth medium, the irrigation intervals can be increased from 2 days to 5-7 days;

It is suggested that this experiment be examined in real conditions of planting in urban green space.

Literature Cited

Almasiyan, F., Astayi, A. and Nasiri Mahallati, M. 2006. Effect of leachate and solid waste compost on yield and yield components of wheat. DESERT (Biaban), 11 (1):89-97. (in Persian).

Barbosa, O., Tratalos, J.A., Armsworth, P.R., Davies, R.G., Fuller, R.A., Johnson, P. and Gaston, K.J. 2007.Who benefits from access to green space? A case study from Sheffield, UK. Landscape and Urban Planning, 83(2): 187-195.

Bialczyk, J., Lechowski, Z., Dziga, D. and Meja, E. 2007. Fruit yield of tomato cultivated on media with bicarbonate and nitrate/ ammonium as the nitrogen source. Journal of Plant Nutrition, 30: 149-161.

Davidson, H., Mecklenburg, R. and Peterson, C. 1994. Nursery management: Administration and culture. Third ed. Englewood Cliffs, NJ, USA: Prentice Hall.

Easton, L.C. and Kleindorfer, S. 2009. Effects of salinity levels and seed mass on germination in Australian species of *Frankenia* L. (Frankeniaceae). Environmental and Experimental Botany, 65(2): 345-352.

Fallahian, A. 2006. Grass construction and maintenance technology. Mashhad University Press, 90 pages. (in Persian).

Gayasinghe, G.Y., Liyana Arachchi, I.D. and Tokashiki, Y. 2010. Evaluation of containerized substrates developed from cattle manure compost and synthetic aggregates for ornamental plant production as a peat alternative. Resources Conservation and Recycling, 54: 1412–1418.

Goos, R.J. 1995. A laboratory exercise to demonstrate nitrogen mineralization and immobilization. Journal of Natural Resources and Life Sciences Education, 24: 68-70.

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

Emami, A. 1996. Plant analysis methods. Soil and Water Research Institute, Iran, pp: 982 (in Persian).

Jankauskien, J. and Brazaity, A. 2008. The influence of various substratum on the quality of cucumber seedling and photosynthesis parameters. Lithuanian Iinstitute of Horticulture, 126 (3): 288- 303.

Mohammadi Torkashvand, A. 2006. Investigating the possibility of using sugarcane molasses as soil modifier. Final Report of Research Project, Faculty of Agriculture, Islamic Azad University of Rasht, Rasht.

Mohammadi Torkashvand, A., Alidoust, M. and Mahboub Khomami, A. 2015. The reuse of peanut organic wastes as a growth medium for ornamental plants. International Journal Recycling Organic Waste Agriculture, 4: 85–94.

Mohammadi Torkashvand, A., Deljooy-e-Tohidi, T., Hashemabadi, D. and Kaviani, B. 2015. Effect of different growth media and fertilization methods on growth characteristics and yield of English daisy. Journal of Science and Technology of Greenhouse Culture, 5 (4): 95-109.

Mohammadi Torkashvand, A., Khanjani, H. and Sedaghathoor, S. 2015. The effect of cow manure compost in cultivation bed and irrigation water salinity on the growth of *Strelitzia reginae.* Trakia Journal of Sciences, 2: 137-142.

Mohammadi Torkashvand, A., Sedaghathoor, S. and Jamalpour, H. 2016. Effects of some organic matter and an artificial moisture absorbent on soil available water, delay of permanent wilting point and the growth of *Lysimachia Nummularia* cv. 'Aurea'. Journal of Water and Soil Science, 20 (75): 87-99.

Mohammadi Torkashvand, A., Shahin, H. and Mohammadi, M. 2017. Growth of olive saplings in different media containing artificial and natural super absorbents at two irrigation intervals. Global Journal of Environmental Science and Management, 3 (3): 312-322.

Mohammadkhani, N. and Heidari, R. 2008. Drought-induced accumulation of soluble sugars and proline in two maize varieties. Journal of World Applied Sciences, 3(3): 448-453.

Moldes, A., Cendon, Y. and Barral, M.T. 2007. Evaluation of municipal solid waste compost as a plant growing media component, by applying mixture design. Bioresource Technology, 98: 3069-3075.

Munns, R. and James, R.A. 2003. Screening methods for salinity tolerance: A case study with tetraploid wheat. Plant and Soil, 253 (1): 201-218.

Nayyar, H. 2003 .Acclimation of osmolytes and osmotic adjustment in water-stressed wheat and maize as affected by calcium and its antagonists. Environmental and Experimental Botany, 50:253-264.

Nayyar, H. and Gupta, D. 2006. Differential sensitivity of C_3 and C_4 plant to water deficit stress: Assosiation with oxidative stress and antioxidants. Environmental and Experimental Botany, 58: 106-113.

Page, A.L., Miller, R.H. and Keeney, D.R. 1982. Methods of soill analysis, Part 2, Chemical and microbiological properties. American Society of Agronomy, Inc. Soil Science of America, Inc. Madison, Wisconsin, USA.

Paranychianakis, N.V. and Chartzoulakis, K.S. 2005. Irrigation of Mediterranean crops with saline water: Fromphysiology to management practices. Agriculture, Ecosystems and Environment, 106: 171-187.

Rahimi Mohammadabad, N., Gholizadeh, F., Zarei, H. and Hemati, H. 2010. Evaluation of proper ratio of sand, rice hull and mushroom compost on qualitative traits of grass. Journal of Plant Environmental Physiology, 2 (34): 52-64.

Robert, D.W. and Browder, J.F. 2005. Chipped pine logs: A potential substrate for greenhouse and nursery crop. HortScience, 40 (5): 1513-1515.

Samiyani, A., Ansari, H., Azizi, M., Hasheminia, M. and Salahurzai, Y. 2014. Effect of drought stress on some biochemical indices in four cover crop species (turf grass (*Lolium prenne*), *Potentilla reptans*, *Trifolium repens* and *Frankinia*) with usability in green space. Journal of Science and Technology of Greenhouse Cultures, 4 (15), 110-101.

Shadanpur, F., Mohammadi Torkashvand, A. and Hashemi Majd, K. 2011. Marigold: The possibilty using vermicompost as the growth medium. Journal of Ornamental Plants, 1(3): 153-160.

Sivapalan, S. 2001. Effect of polymer on soil water holding capacity and plant water use efficiency. Proceedings of the 10th Agronomy Conference, Hobart, Tasmania, Janurary 2001.

Stocker, O. 1960. Physiological and morphological changes in plant due to water deficiency. Central Arid Zone Research Institute, 15: 63-94.

Tardieu, F. 2005. Plant tolerance to water deficit: Physical limits and possibilities for progress. Geoscience, 337: 57-67.

Verdonck, O. and Gabriels, R. 1992. I. Reference method for the determination of physical properties of plant substrates. II. Reference method for the determination of chemical properties of plant substrates. Acta Horticulturae, 302: 169-179.

How to cite this article:

Majidi, M., Mohammadi Torkashvand, A., and Ebrahimi, R. 2019. Investigating growth of Frankenia thymifolia as a cover plant during drought stress in different growth media and irrigation periods. *Journal of Ornamental Plants,* 9(3), 179-191.

URL: http://jornamental.iaurasht.ac.ir/article_667492_7ece37397e66b85aa2de4e4c984fc365.pdf