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Original article

Investigation of drought resistance of tarragon (*Artemisia dracunculus L.*) under different levels of titanium nanoparticles

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Extended abstract

Introduction

Iran is one of the arid and semi-arid regions of the world with an average rainfall of 240 mm per year. Water scarcity is one of the most important abiotic stresses that adversely affects the yield of garden plants. However, the use of new technologies such as nanoparticles can be effective in improving plant performance. Metal nanoparticles such as nano-titanium, zinc, iron, aluminum and silver can be effective in increasing the supply of elements in the roots and shoots of plants. Recently, the use of titanium nanoparticles has been highly regarded by plant physiologists due to its outstanding properties.

Materials and methods

For this purpose, a factorial experiment based on a completely randomized design with four replications on tarragon (Artemisia dracunculus) was designed and conducted at Ferdowsi University of Mashhad. Experimental treatments included three levels of drought stress (90, 70 and 50% of field capacity) and three levels of nano titanium dioxide (0, 10 and 20 ppm). The method of applying titanium dioxide nano treatments was foliar spraying. In this way, the above treatments were sprayed on tarragon leaves in four stages every seven days (two stages before stress and two stages after drought stress). At the end of the experiment, the following traits were measured. Plant height, number of lateral stems and number of leaves per plant were recorded. Dry weight of shoot, root and total dry weight after drying in an oven at 70 ° C for 48 hours were measured with a digital scale with an accuracy of 0.001. Stem diameter, root length and root diameter were calculated with a digital caliper and leaf area with a leaf area meter. Relative water content, electrolyte leakage, chlorophyll a, chlorophyll b, total chlorophyll and carotenoids, total carbohydrates and percentage of antioxidant activity were measured

Results and discussion

According to the results, the highest shoot and root dry weight of tarragon were in 90% of irrigation and foliar application with 10 and 20 ppm titanium dioxide and also the lowest percentage of antioxidant activity (49%) and the percentage of total carbohydrate solution (14%) was seen in 90% FC and in the absence of foliar application with nano titanium dioxide. Root diameter, height and stem diameter increased by 41.8%, 39.5%, and 42.2% in 90% FC and 10 ppm nano titanium dioxide compare to 0 ppm nano titanium dioxide at the same drought levels (90% FC). By increasing the concentration of nanoparticles from 0 to 20 ppm these traits increased by 16.4, 8.8 and 16.5% respectively, at 50% FC. As the results show, the dry weight of the plant decreased under drought stress. In fact, plant dry weight is affected by plant growth and photosynthesis process and decreases with decreasing photosynthesis under stress conditions. On the other hand, the condition of plants in drought stress conditions is

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improved by the use of nano titanium and the dry weight of the shoot is increased. Studies have also shown that drought stress significantly reduces the content of chlorophyll a, b, total chlorophyll and carotenoids. On the other hand, an increase in chlorophyll content under stress conditions has been reported due to the use of nano-titanium

Conclusions

In general, although drought stress reduced morphological traits and photosynthetic pigments in tarragon, foliar application of titanium dioxide at concentrations of 10 and 20 ppm was effective in improving these traits. It has been reported that titanium nanoparticles may increase photosynthesis and efficiency by increasing light reception and increase the plant's carbohydrate production potential. Studies by Soltani et al. Have shown that titanium nano dioxide has an effect on the activity of antioxidant enzymes such as catalase, peroxidase and ascorbic peroxidase.

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Keywords: Antioxidant, Dry weight, Pigment, Relative water content

Table 1. Some physical and chemical traits of the soil used in the experiment

Soil Texture	Sand	Silt	Clay	N	K	P	pH	EC
	--------%--------				----ppm----			ds/m
Lumi Silt	51	30	19	0.1	51.2	30.5	6.8	1.5

Table 2. Analysis of variance (Mean Squares) for effect of nano titanium dioxide on morphological studied traits under drought stress

S.O.V	df	Stem diameter	Number of leaves	Number of lateral stems	Stem height	Leaf area
Drought (D)	2	163.2**	1574.8**	17.69**	970.6**	1104.1**
TiO_2	2	209.8**	532**	1.36*	251.5**	541.02**
D× TiO_2	4	16.03**	128.08**	0.27ns	59.71**	29.44ns
Error	27	2.27	19.49	0.36	9.63	14.01
CV(%)		*19.64*	*30.94*	*39.06*	*24.19*	*21.49*

Table 2. Continued

S.O.V	df	Root diameter	Root length	Total dry weight	Root dry weight	Shoot dry weight
Drought (D)	2	212.1**	5135.2**	0.427**	0.046**	0.199**
TiO_2	2	272.6**	1330.5**	0.159**	0.020**	0.064**
D× TiO_2	4	20.84**	315.9**	0.010*	0.002**	0.004*
Error	27	2.95	50.98	0.003	0.0003	0.001
CV(%)		*19.64*	*24.19*	*30.07*	*33.13*	*29.33*

* and ** Significant difference at 5 and 1% respectively, and ns indicates no significant difference

Table 3. Mean comparison of Nanosized titanium dioxide on morphological studied traits under drought stress

Treatments		Shoot dry weight	Root dry weight	Total dry weight	Root length
Drought	$NTiO_2$				
%FC	ppm	------------gr/plant------------			mm
90	0	0.43^{c}	0.18^{c}	0.61^{c}	59.85^{d}
	10	0.64^{a}	0.27^{ab}	0.92^{a}	65.17^{d}
	20	0.56^{ab}	0.23^{b}	0.79^{ab}	70.42^{d}
70	0	0.40^{cd}	0.17^{cd}	0.57^{cd}	76.27^{cd}
	10	0.54^{b}	0.29^{a}	0.83^{ab}	93.90^{b}
	20	0.49^{bc}	0.26^{ab}	0.75^{b}	100.29^{b}
50	0	0.25^{e}	0.11^{e}	0.36^{e}	89.15^{bc}
	10	0.33^{de}	0.14^{cde}	0.47^{de}	124.20^{a}
	20	0.30^{e}	0.13^{de}	0.43^{e}	105.24^{b}

Table 3. Continued

Treatments		Root diameter	Stem height	Number of leaves	Stem diameter
Drought	$NTiO_2$				
%FC	ppm	------mm------			mm
90	**0**	26.50^{bc}	38.76^{bc}	37.75^{b}	23.25^{bc}
	10	37.62^{a}	54.00^{a}	57.25^{a}	33.00^{a}
	20	35.91^{a}	45.76^{b}	62.50^{a}	31.50^{a}
70	**0**	23.08^{cd}	33.16^{cd}	32.00^{bc}	20.25^{cd}
	10	28.78^{b}	40.82^{b}	37.50^{b}	25.25^{b}
	20	33.90^{a}	43.60^{b}	37.25^{b}	29.73^{a}
50	**0**	21.32^{d}	26.02^{d}	26.00^{c}	18.70^{d}
	10	24.89^{bcd}	28.33^{d}	34.00^{bc}	21.83^{bcd}
	20	28.67^{b}	30.61^{d}	32.00^{bc}	25.15^{b}

Means that have common alphabetic in each trait do not significant difference at level%5 base on Tukey HSD test

Table 4. Mean comparison of some studied traits in different drought stress and Nano titanium dioxide levels

Treatments		Leaf Area	Number of lateral stems	Cartonoeid	Relative water content
		cm^2		mg/g	%
Drought (%FC)	**90**	59.00^{a}	4.00^{a}	0.378^{a}	74.25^{a}
	70	45.83^{b}	3.41^{a}	0.223^{b}	57.08^{b}
	50	40.33^{c}	1.66^{b}	0.195^{b}	44.75^{c}
$NTiO_2$ (ppm)	**0**	40.91^{b}	2.66^{b}	0.233^{b}	54.66^{b}
	10	53.91^{a}	3.33^{a}	0.287^{a}	62.00^{a}
	20	50.33^{a}	3.08^{ab}	0.276^{a}	59.41^{a}

Means that have common alphabetic in each trait do not significant difference at level%5 base on Tukey HSD test

Table 5. Analysis of variance (Mean Squares) for effect of nano titanium dioxide on physiological and biochemical studied traits under drought stress

S.O.V	df	Chlorophyll a	Chlorophyll b	Total chlorophyll	Cartonoeid
Drought (D)	2	0.112^{**}	0.104^{**}	0.399^{**}	0.116^{**}
TiO_2	2	0.026^{**}	0.020^{**}	0.093^{**}	0.009^{**}
D× TiO_2	4	0.006^{**}	0.005^{**}	0.016^{**}	0.001^{ns}
Error	27	0.001	0.0009	0.002	0.0008
CV%		*22.55*	*31.07*	*24.23*	*33.74*

Table 5. Continued

S.O.V	df	Relative water content	Electrolyte leakage	Antioxidant activity	Total carbohydrates
Drought (D)	2	2634.11^{**}	1345.2^{**}	1941.5^{**}	62023.6^{**}
TiO_2	2	166.02^{**}	417.1^{**}	483.5^{**}	44061.6^{**}
D× TiO_2	4	8.52^{ns}	89.6^{**}	56.42^{**}	5693.48^{**}
Error	27	9.67	4.43	4.43	458.7
CV%		*22.11*	*15.12*	*15.12*	*25.82*

* and ** Significant difference at 5 and 1% respectively, and ns indicates no significant difference

Table 6. Mean comparison of Nanosized titanium dioxide on physiological and biochemical studied traits under drought stress

Drought	$NTiO_2$	Chlorophyll a	Chlorophyll b	Total chlorophyll	Electrolyte leakage	Antioxidant activity	Total carbohydrates
%FC	ppm	---------------------mg/g FW---------------------			%		mg/g
	0	0.447^{bcd}	0.337^{b}	0.785^{b}	67.47^{c}	49.065^{e}	14.65^{f}
90	**10**	0.595^{a}	0.442^{a}	1.037^{a}	49.65^{e}	67.47^{c}	32.47^{cd}
	20	0.525^{ab}	0.432^{a}	0.957^{a}	59.05^{d}	59.05^{d}	26.05^{e}
	0	0.392^{cde}	0.232^{cd}	0.625^{cd}	80.10^{ab}	66.05^{c}	28.05^{de}
70	**10**	0.510^{ab}	0.295^{bc}	0.805^{b}	66.05^{c}	77.80^{ab}	36.80^{abc}
	20	0.477^{ab}	0.242^{cd}	0.720^{bc}	77.80^{ab}	80.10^{ab}	41.10^{a}
	0	0.315^{e}	0.177^{d}	0.492^{e}	82.32^{a}	75.17^{b}	34.17^{bc}
50	**10**	0.320^{e}	0.222^{cd}	0.542^{de}	78.82^{ab}	82.32^{a}	41.32^{a}
	20	0.362^{de}	0.292^{bc}	0.655^{cd}	75.17^{b}	78.82^{ab}	38.35^{ab}

Means that have common alphabetic in each trait do not significant difference at level%5 base on Tukey HSD test